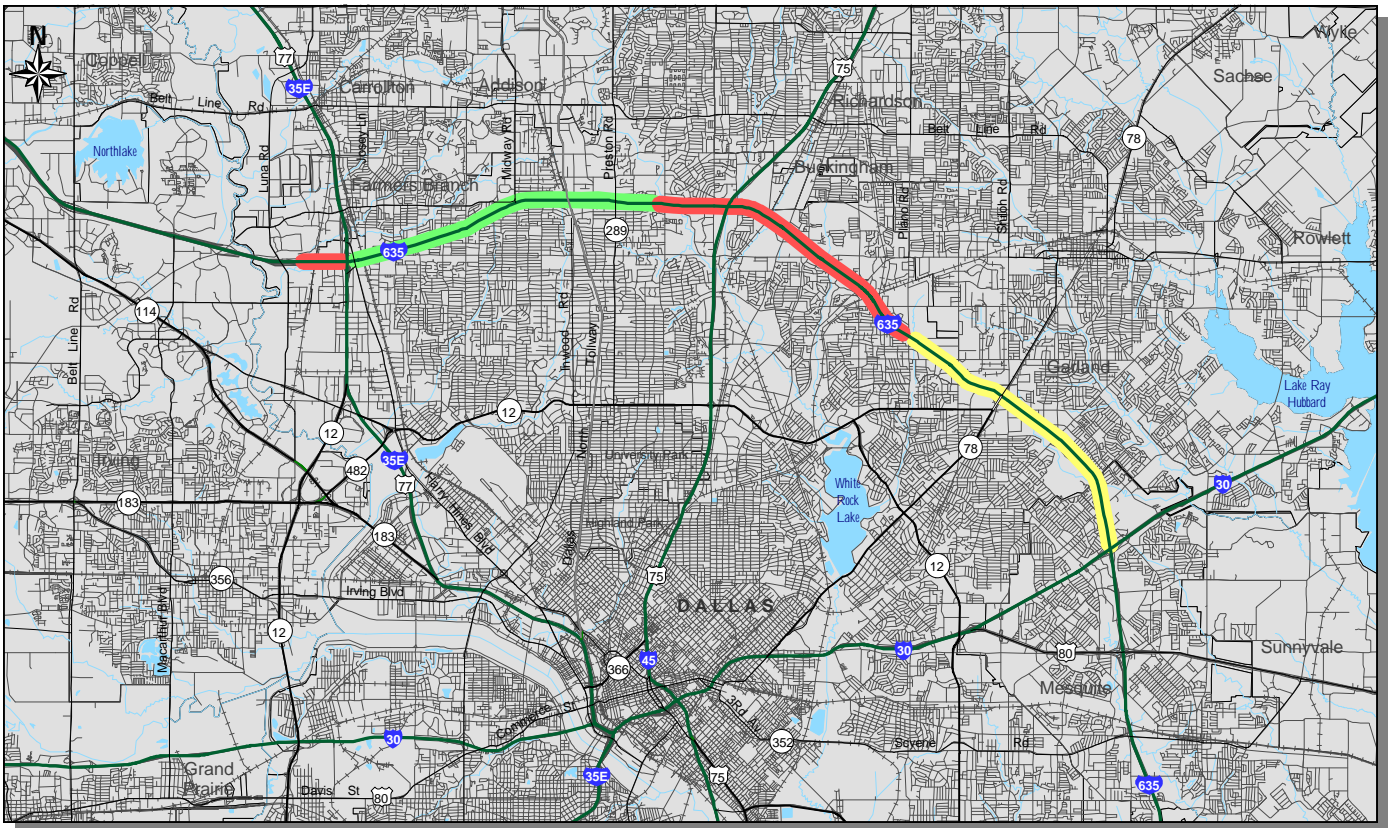


LBJ MANAGED LANES

Traffic and Revenue Study



ENGINEERS
PLANNERS
ECONOMISTS

Wilbur Smith Associates

LBJ MANAGED LANES

Traffic and Revenue Study

Prepared for
Texas Department of Transportation
in association with
HNTB

Prepared by



March 2002

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March 12, 2002

Mr. Matthew MacGregor
LBJ Project Manager
TxDOT LBJ Project Office
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Dear Mr. MacGregor:

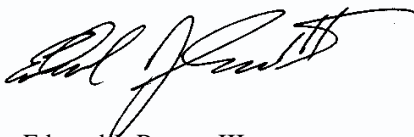
Wilbur Smith Associates is pleased to submit this report of our Phase II study of the proposed Managed Lanes on the LBJ Freeway. This study supports the conclusion that the LBJ Managed Lanes (LBJMLs) has the capability of providing enhanced regional mobility, multi-modal transport system integration, system and corridor travel mode balancing, substantial toll-based revenues, transport system and services performance increases and bus rapid transit services (BRT).

Given the nature of BRT and its ability to support value capture facility financing strategies, it would be prudent to evaluate: (1) the potential for these strategies to work in this policy/institutional context, and (2) the degree to which they might support total project costs.

The results of this study were prepared without the benefit of the Year 2000 Census and were completed before the announcement of significant federal defense contract awards to employers in the greater Fort Worth/Dallas region that could substantially increase travel in this corridor. In this context, it would be prudent to undertake further evaluations of a reduced set of scenarios over a multi-year period with the benefit of Year 2000 Census-based forecasts of population and employment. As this Phase II study shows, just a small shift in annual growth rates results in markedly different VMT and revenue results.

Both I and our Project Manager, Paul J. Pezzotta, wish to thank you for the opportunity to work with you on this exciting and innovative project. We look forward to working with you to assist in future assessments of the facility's traffic and revenue performance.

Very truly yours,
WILBUR SMITH ASSOCIATES



Edward J. Regan, III
Senior Vice President

Albany NY, Anaheim CA, Atlanta GA, Baltimore MD, Bangkok Thailand, Burlington VT, Charleston SC, Charleston WV, Chicago IL, Cincinnati OH, Cleveland OH, Columbia SC, Columbus OH, Dallas TX, Dubai UAE, Falls Church VA, Greenville SC, Hong Kong, Houston TX, Iselin NJ, Kansas City MO, Knoxville TN, Lansing MI, Lexington KY, London UK, Milwaukee WI, Mumbai India, Myrtle Beach SC, New Haven CT, Orlando FL, Philadelphia PA, Pittsburgh PA, Portland ME, Poughkeepsie NY, Raleigh NC, Richmond VA, Salt Lake City UT, San Francisco CA, Tallahassee FL, Tampa FL, Tempe AZ, Trenton NJ, Washington DC

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EXECUTIVE SUMMARY

Wilbur Smith Associates is pleased to submit this final report of our Phase II study of the proposed Managed Lanes (ML) on the LBJ Freeway in Dallas, Texas. This Phase II Report was undertaken to better inform decisions as to:

- ✍ The scale of the facility and the capability of the Managed Lanes to support various transportation system objectives for the corridor and the larger region;
- ✍ The compatibility of the facility footprint with the needs of the most advanced electronic payment technology systems;
- ✍ The level of market-based revenues that could be expected to support the overall construction costs; and
- ✍ Other operational features of the proposed design.

ML is a term of art developed by the larger TxDOT planning community and is defined by that community as:

“A managed lane facility is one that increases freeway efficiency by packaging various operational and design actions. Lane management operations may be adjusted at any time to better match regional goals.”

This study supports the conclusion that within this corridor, the LBJMLs can be seen as having the capability of providing:

- ✍ Enhanced Regional Mobility,
- ✍ Multi-Modal Transport System Integration,
- ✍ System and Corridor Travel Mode Balancing,
- ✍ Revenue Development, Transport System and Services Performance Increases

As a result of this assessment, the LBJMLs are seen to hold the potential to significantly add to corridor mobility through the use of variable tolling and its ability to provide a mobility platform that could support Bus Rapid Transit (BRT). The Electronic Tolling (ETC) capabilities that are a fundamental component of this advanced transport concept, will allow regional transportation system planners to deliver a level of service and facility performance that will bring the region far closer to actualizing a transport system ideal of a regional seamless web of mobility across multiple modes.

It is clear from the work completed in this study, that the LBJML facility can accommodate the state of the art technology needed to bring all these capabilities to the region's drivers and transit users. Chapter 5 provides a conceptual design to accommodate the technology needs to make the system's promise a reality. Should this capability become operational across the region's major transport facilities and services, it will allow for significantly enhanced transport systems and infrastructure investment performance.

Given the structure of the operational scenarios evaluated in this study and economic and demographic data used to support those scenarios, the forecasted levels of traffic and revenue for the LBJMLs completed in this study can be useful in evaluating the efficacy of building five General Purpose (GP) lane vs. the four GP lane alternatives. By reviewing the performance measures reported in Chapter 4 of this report, one can see a rather substantial reduction in revenues occurs, amounting to 40-48 percent, if the five GP lane alternative is built as compared to the four GP lane alternative.

The VMT reduction in the MLs for five GP lanes vs. four GP lanes alternatives varies from approximately 14 to 19 percent depending on the tolling policy for HOVs that is pursued. The fall off in VMT is less than the revenue fall off, because even as congestion on the GP lanes falls in the five-lane scenario as compared to the four-lane scenario, enough congestion remains to encourage a sizable number of drivers to continue to use the tolled MLs at a substantially reduced toll rate.

While the five GP lane Scenario provides relatively higher travel speeds for the GP lanes, it comes at a very steep cost to the revenues generated in the ML. Clearly, policymakers will have to evaluate the operational objectives they anticipated that the facility would achieve as opposed to revenues generated to see if sufficient returns are achieved in these critical measures of facility performance under the four GP lane vs. five GP lane scenarios.

Of course the construction costs of the five GP lane scenarios as opposed to the four GP lane scenarios would play a large role in the policy decision as to whether to build the four or five GP lane facility. That information is beyond the scope of this study but is available to policymakers.

The study team also evaluated building fewer access ramps to the ML facility. The results suggest that the reduced access to the ML lanes apparently constrains its use by carpoolers. The effect of this outcome is to drive up congestion in the GP lanes thereby creating more of an incentive

for SOVs to pay a toll. So the revenues increase as access is constrained, see Chapter 4 for a fuller discussion.

Two scenarios were developed to demonstrate the effect of growth on the use of the MLs. Structurally, the Global Demand in these two scenarios was set at a level 15 percent higher than that of the regionally accepted 2015 levels of travel that were modeled as the study year for this assessment. When the traffic and revenue results for these scenarios are compared to the base year's results, one can see a 75 percent increase in revenue while the VMT grows by only 20 percent. This clearly demonstrates the effect on the traveling public of increasing congestion and the resultant travel time savings increase one can gain from use of the MLs.

This demonstration shows the importance of having very accurate forecasts for regional population and employment as a basis for this type of analysis. The results of this Phase II study were prepared without the benefit of the Year 2000 Census and was completed before the announcement of significant federal government defense contract awards that could substantially increase travel and development in this corridor. In addition, it is clear that both DART, Tri Rail and TxDOT are proposing to make very substantial investments in infrastructure in this corridor, which will significantly increase its accessibility and attractiveness as a location for all manner of activities.

Given these developments, it would seem prudent to undertake further evaluations of a reduced set of the scenarios presented in this report, but over a multi-year assessment period and with the benefit of more recent estimates of population and employment growth for the region. Should these forecasts show just a small annual growth rate increase coupled to somewhat different distributions of origins and destinations brought on by new development or re-development activities, the facility could show markedly different VMT and revenue results.

Obviously this facility is not a private toll road run for profit maximization. Current policy analyses undertaken within the transportation planning profession would suggest that for innovative facilities such as the LBJMLs a sensitive balance must always be maintained between the pursuit of revenue generated as compared to the speeds in the GP lanes or the political consensus needed to support the construction of a network of ML facilities in the region might be seriously jeopardized. Clearly, these Scenarios do not depict any conflict such as this, but under some higher growth scenarios, attention to such issues might be warranted. However, should this become an issue, the LBJ

Freeway corridor has within it the ability to accommodate five GP lanes. This circumstance allows policymakers to construct a fourr GP lane configuration and observe the system performance as population and economic development expand in the region. Should travel speeds begin to deteriorate too dramatically in the GP lanes relative to that of the MLs, and then it would be possible to add the fifth lane so that GP lane performance would not be too significantly different from ML performance.

The selection of this implementation strategy should likely await the preparation of traffic and revenue forecasts based on Year 2000 Census. Furthermore, it should not be made in the absence of consideration of construction cost information for each scenario, but it is clear using just the information in this study that the five GP lane scenario seriously erodes the use of the tolled MLs.

The other major decision that could be evaluated based on information developed in this study is the determination as to whether one should build a reduced access configuration or a base-case access configuration. While there is information presented in this study to inform such a decision, it would be prudent to put that decision off until better information related to population and employment in future years is available, The distribution and levels of the these demographic and economic dimensions of the transport modeling process could materially affect that decision. Of course the costs of construction of the two alternative access-level scenarios would also play a major role in this decision.

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CHAPTER 1

INTRODUCTION

The LBJ Freeway (I.H. 635) is the major circumferential roadway in the Dallas region. As such, its traffic loadings have grown steadily as the region has grown. Traffic on certain sections of the LBJ Freeway (LBJ) is heavily congested for many hours of each day. Given the vitality of the region's economy and its history of growth, this condition is likely to deteriorate further if no improvements are made.

So that it can continue to serve the region well, the Texas Department of Transportation (TxDOT) is evaluating the re-configuration of its design so that the facility can maintain corridor mobility as travel needs and conditions continue to evolve. A recently completed Major Investment Study continues along the already established policy path that supports the conclusion that a High Occupancy Vehicle/Toll Lane (HOT Lanes) would be a primary element of the preferred alternative. The nearly completed National Environmental Protection Act (NEPA) process appears to be moving in towards the same conclusion.

The term Managed Lanes (ML) has emerged within the state's facility planning and systems management community as a term of art for a class of facilities, some of which incorporate the features being investigated in this report for the LBJ Freeway. Managed Lanes, as defined by the extended TxDOT-related planning community can incorporate a far broader set of design features than just those being investigated for the LBJ facility, and for purposes of clarity, the formal definition of Managed Lanes as used by this planning community is shown as follows:

"A managed lane facility is one that increases freeway efficiency by packaging various operational and design actions. Lane management operations may be adjusted at any time to better match regional goals."

This term is finding some use in planning circles around the nation, and as it does, its precise meaning may evolve, but for the purposes of this study, we will adhere to this strict interpretation of the term.

In the case of the LBJ Managed Lanes (LBJML), the movement to the use of the term of Managed Lanes as opposed to HOT Lanes seems far more appropriate in that it communicates that the facility is far more than simply an HOV lane with a simple Single Occupant Vehicle-toll (SOV-toll) buy-in. In the case of the LBJML, the term relates to the potential addition of real time, variable tolling and the potential for broadened buy-in by multiple vehicle types and modes including light-duty trucks, single-occupant vehicles, and varying occupancy levels of HOVs. Buses would still be free users. However, the potential broadened consideration of Bus Rapid Transit service in the corridor creates further support for the distinguishing term.

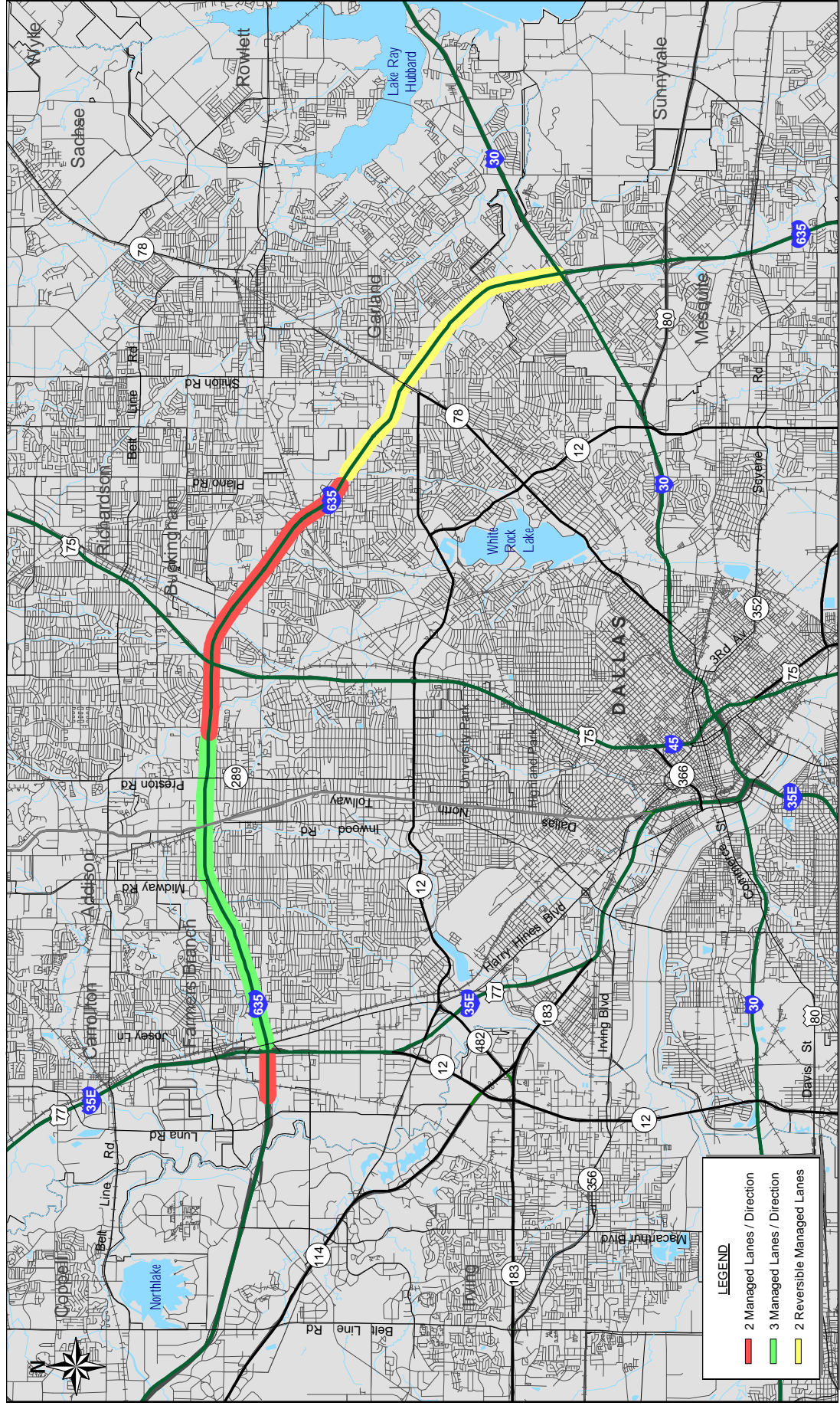
Wilbur Smith Associates (WSA) has prepared this operational and financial assessment of the concept in order to assist TxDOT, its regional institutional partners and the larger community of businesses and residents to better understand the ultimate characteristics of the LBJ once the improvements are made.

PROJECT DESCRIPTION

Figure 1-1 shows the LBJML facility as it is currently conceived as an operating facility in 2015, the forecast year for this study, the LBJ Managed Lane Preliminary Feasibility Study, Phase II. It will run approximately 20 miles from Luna Road on the west to I.H.-30 on the east. As shown in Figure 1-1, it will be of varying capacity over its length:

- ✍ From Luna Road through Josey Lane, it will be comprised of two lanes per direction;
- ✍ From Josey Lane through Preston Road, it will be three lanes per direction;
- ✍ From Preston Road through Plano Road, it will be two lanes per direction; and
- ✍ From Plano Road through I.H.-30, it will be comprised of two reversible lanes, which only operate during peak periods.

The available space for capacity improvements is very limited in the corridor. In the area between Josey Lane and Midway Road, where the proposed improvements include three MLs in each direction, the MLs will be located below grade in both cut and cover and partially open cut



PROJECT LOCATION MAP

FIGURE 1-1

sections. Portions of this below grade section of the LBJMLs will be under the frontage roads on either side of the general purpose (GP) lanes.

In the section between Midway and Preston Roads, a distance of approximately two miles, the MLs will be located in two mined tunnels. On either end of this area, from Luna Road to Josey Lane and from Preston Road to I-30, the MLs will typically be located at-grade in the median of the GP lanes.

MANAGED LANES ACCESS

There are several different access locations and types of access to and from the MLs proposed for this study. This study evaluated two different access scenarios. The access scenarios are shown in Figure 1-2.

In the “base” access scenario, there are 5 access points directly between the GP lanes and the MLs in each direction. Included in this scenario are the termini points in each direction at Luna Road and I.H.-30. In addition to these access points, access would also be provided from frontage roads, cross streets, and DART Transit Centers, using nine ramps in each direction. Finally, access would also be provided by direct connector ramping with I-35E, U.S. 75 and I.H.-30.

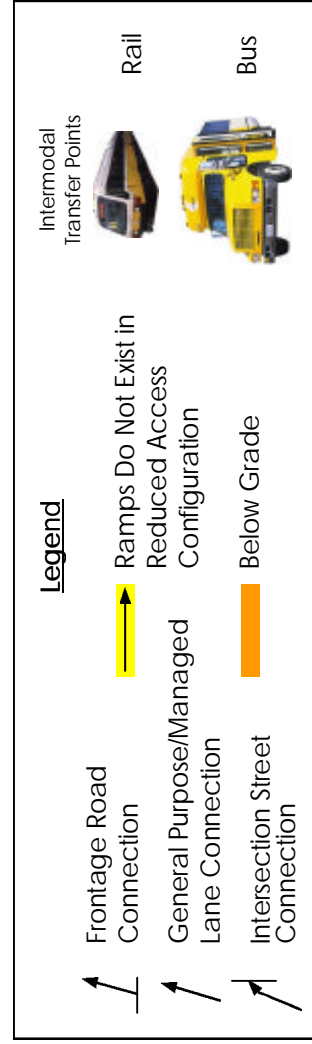
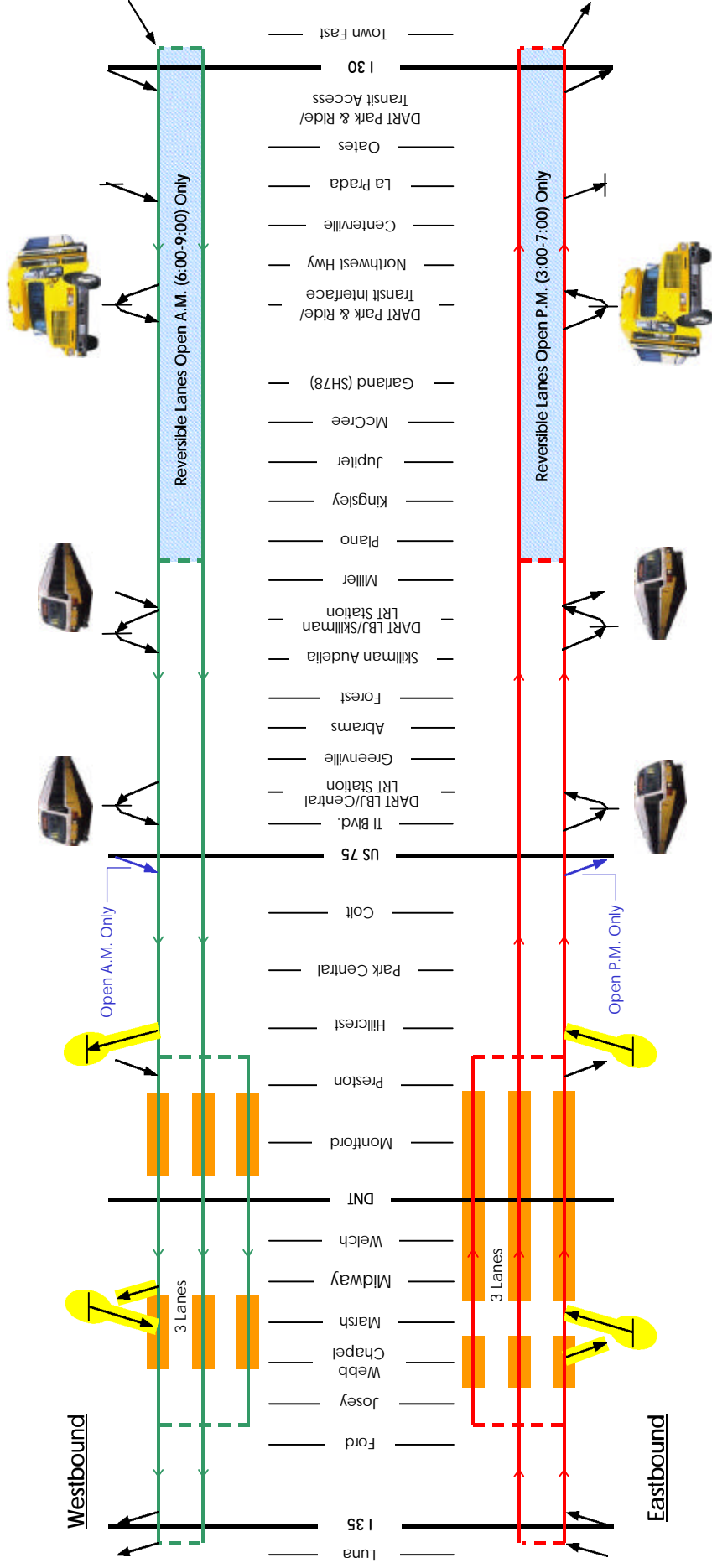
In the reduced access scenario, one GP/ML access point and two frontage road/ML access points would be deleted in each direction.

The three exit ramps in the westbound, base scenario take traffic directly to intersecting streets. Three entries and three exit ramps directly between the managed lanes and the LBJ GP lanes. Two of these would not be included in the reduced access scenario. There would also, of course, be direct access between the main lanes and the managed lanes at the two end points, i.e., just west of I.H. 35 and just east of I.H. 30.

Figure 1-2 also notes the potential for multi-modal travel at intersections with Dallas Area Rapid Transit (DART) Light Rail Transit (LRT) service in the vicinity of TI Boulevard and Skillman Avenue. Major Bus Transit Centers and park-and-ride facilities located in the vicinity of Shiloh Road and I.H.-30 will create the opportunity for expanded HOV use on the facility. While Bus Rapid Transit (BRT) service is not currently in DART’s program for the facility, it is a service format that could be considered for implementation on this facility as well as the network of MLs that are being evaluated by TxDOT, DART, North Central Texas Council of Governments (NCTCOG) and other facility and service planners in the region.

LBJ Freeway Managed Lanes Study

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MANAGED LANES - ACCESS LOCATIONS

FIGURE 1-2

REVERSIBLE OPERATIONS

Figure 1-2 also shows operating assumptions for the reversible lane portion of the LBJML, from west of Plano Road to I.H.-30. For purposes of this study, it was assumed that this section would be opened in the westbound direction only between 6:00 and 9:00 a.m. Further, it was assumed to be opened in the eastbound direction only between 3:00 and 7:00 p.m. Finally, it has been assumed that the reversible lane section would not be opened during any other hours, including the six-hour midday period between 9:00 a.m. and 3:00 p.m. The actual hours of operation of the commercial lanes may vary slightly when implemented. As will be described in more detail later, this section will feature five to six lanes of GP lane travel capacity in each direction; hence, there will be little demand for toll traffic on the reversible lanes during the midday period in any case.

As with most features of MLs, the hours of operation of the reversible lanes could, in the future, be modified to stay open in the westbound direction until 11:00 a.m. and open at 1:00 p.m. in the eastbound direction. And while there is no revenue being generated in the down time for this portion of the facility, these hours represent a very good opportunity to maintain the facility without creating congestion and delays on a toll-charging facility.

STUDY OBJECTIVES

While the potential of the ML concept is very high, the achievement of its benefits must first be demonstrated through study and analysis of its operational and revenue characteristics. This study represents a refinement of those facility characteristics, which were raised as a result of the work completed in the Phase I study. The objective of the Phase I study was to determine if “HOT lanes on the LBJ Freeway could be an effective mechanism to provide a non-congested alternative for HOVs and for SOVs willing to pay a toll.” It was determined in that study “that tolls could be used to keep HOT lanes flowing smoothly during congested periods.”

The first area of refinement represented by this Phase II study is focused on:

- ✍ The development of a more accurate set of revenue projections that cover a broader range of alternative operational designs for the LBJML.

- ✍ The assessment of the technology-related issues and inter-organizational-management related issues as they affect the achievement of the facility's potential benefits.

To achieve the improvement in revenue projections, it was determined a higher degree of detail was needed in the area of traffic counts. This would enable a more refined modeling and therefore a better assessment of revenue potential for the facility.

The revenues achieved by an advanced facility such as this are heavily affected by the ability to vary prices dynamically as traffic volumes vary on the GP lanes and the ML. This ability, in turn, is largely a function of the ability to fit the needed technology, i.e., information systems, into the facility footprint, and, to a lesser degree, to be able to coordinate pricing with other value pricing projects and other priced transport facilities, e.g., toll roads, rail and bus transit, parking facilities, etc.

Therefore, the second major operational refinement included in this study as compared to the Phase I study relates to:

- ✍ Geometry of the facility to accommodate variable and/or dynamic pricing equipment; and
- ✍ Degree of inter-agency coordination achievable given their current Intelligent Transport Systems (ITS) technology base and proposed ITS strategy as compared to that required for the systems to function at the level needed to secure the benefits potentially available to the region.

The technology assessment would enable the region's other transport facility operators to determine how best to move forward in coordinating the technological evolution of their systems' capabilities in a manner that enables greater benefits for the region's transportation system users and supports higher levels of returns to the region's economy.

SCOPE OF PROJECT SERVICES

To successfully achieve the objectives of the study, WSA undertook an intensive upgrade of the analytical tools used in the Phase 1 effort. Study elements included:

- ✍ Upgrade the LBJ Corridor Travel Characteristics database via a comprehensive travel time, traffic count and vehicle occupancy count program;
- ✍ Refine the model chain to more accurately include the effects of congestion on an interactive basis as toll rates shift on the managed lanes and congestion subsequently increases or decreases on the GP Lanes;
- ✍ Refine the global demand estimates to more accurately reflect the impact of latent demand and other interactive/feedback effects of developing multi-modal travel platform in the LBJ corridor;
- ✍ Develop a more refined and integrated ML Market Share Model chain to estimate vehicle use by vehicle class at various travel time savings and toll levels;
- ✍ Analyze traffic and revenue potential at various toll rates for each of 10 operational scenarios for a.m. peak, midday and p.m. peak periods;
- ✍ Work with the LBJML Project Team to create a cross section of alternative operational designs that create sufficient variety to capture the opportunities presented for ML use in the Dallas region;
- ✍ Evaluate the need for and results from the implementation of fixed pricing, variable pricing, and dynamic pricing on the success of the LBJML facility within the context of the 10 operational scenarios developed by the LBJML Project Team;
- ✍ Based on those results, evaluate the feasibility of implementing the needed technology on the LBJML facility given the proposed geometry of the facility;
- ✍ Based on discussions and prior work with participating agencies of the LBJML Project Team, identify management and operations issues that would require further coordination for the successful implementation of the LBJML facility; and
- ✍ Identify, where appropriate, areas where further work would be needed to address significant issues and opportunities in the successful implementation of the LBJML Project.

OVERVIEW OF THE MANAGED LANE TRANSPORTATION CONCEPT IN THE CONTEXT OF THE LBJ FREEWAY

The configuration of HOT lanes that TxDOT is evaluating for the LBJ is an innovative form of HOV lanes. This innovative design platform under consideration for the LBJ Freeway is one of a class of facilities that TxDOT and its planning partners have come to term Managed Lanes, as defined above.

While the original design concept of HOV lanes has had some difficulties in meeting regional transport objectives as defined in various projects around the nation, the re-configuration of HOV lanes into HOT lanes has shown some positive advances in meeting some of the identified shortcomings of these HOV lane projects. Based on these successes, transportation-planning agencies in the state of Texas have further refined and extended the HOV concept and imbedded it into a larger framework, which they now term Managed Lanes.

HOV Lanes were originally designed to create a time savings incentive for the formation of carpools and vanpools during the era when the attainment of the U.S. EPA's national ambient air quality standards (NAAQS) for hydrocarbons (HC), nitrogen oxides (NOX) and carbon monoxide (CO) drove a great deal of the infrastructure policy agenda. And while HOV lanes have been in existence for many years, they have had mixed success depending on their application and the context in which they have been used.

To enhance this effectiveness, several years ago HOV lanes were modified into HOT lanes, with SR 91 in California being the first of this type of service platform to be successfully implemented. In concept, these lanes allowed HOVs at some levels of occupancy to travel in them free, but, under the HOT format, they also allowed Single Occupant Vehicles (SOVs) to buy the unused, excess capacity in the lanes via a toll.

In some travel markets, the HOV concept was modally upgraded to BRT Lanes, i.e., lanes specifically dedicated to bus vehicles as a means to give incentive to bus travel in a region or corridor.

Into this policy environment, highway and transit planners devised yet still another form of the HOV lane, i.e., the Managed Lane. TxDOT and the larger transportation planning community in the Dallas region potentially see ML Systems as providing a corridor or circumferential facility like the LBJ with a predictable level of service or mobility for potentially all

vehicle types, including emergency vehicles, trucks, SOVs, HOVs at various occupancy levels and BRT. In addition to the ability of tolls to provide a predictable level of service for the facility, the composition of vehicles that actually use the facility can also be varied/controlled through the use of tolls, hence the name, “Managed Lanes.”

Because MLs as envisioned for the LBJ Freeway can only be implemented through the use of advanced Intelligent Transportation Systems (ITS), e.g., electronic toll collection (ETC) techniques, the use of ML in the LBJ corridor leads to two very significant potential benefits/capabilities of this new modal platform, that of enhanced modal integration together with corridor and system balancing capabilities. This ability is derived from the capability to price multi-modal trips at discounted rates or to “cross-incentive” travel on other regional modes or systems. One can do this on a daily, weekly or monthly basis.

For example, if a rail system exists in the same corridor as a highway facility, e.g., the proposed DART facilities that are under construction and which are planned for construction into the northern areas of the Dallas region, through the use of pricing packages one might discount the toll road and/or rail systems’ use if a commuter used both the ML and the rail system. This approach would provide more capacity in the road network at very little cost while increasing the use of a system, which may have excess capacity.

In addition to the feature that mobility is virtually guaranteed on a ML toll facility, assuming the absence of accidents, natural disasters and the like, it has an added characteristic that it shares with HOT lanes in that it is a revenue generating facility. MLs also have the advantage of being able to generate revenues from all vehicle types on the ML facility, not just SOVs. This is only one of several attractive new financing sources that ML implementation holds for both transit and highway systems.

This is significant for the economy of the region. By adding another revenue source to the transport financing strategies already available, a region using these tools can potentially make itself more competitive with respect to other regions by being able to support a more modern, more capable and more productive transportation system. In this case, the LBJML multi-modal facility can facilitate the expansion of the economy by creating enhanced corridor mobility and accessibility to further support economic expansion.

Because MLs can support both enhanced suburban auto mobility and enhanced transit capabilities within an auto based land-development

format, they offer the option of supporting an auto-compatible form of Transit Oriented Development (TOD) within an auto-dominant mobility environment. This potential to increase densities of development as well as person trips within a rubber-tire based mobility corridor, effectively presents the opportunity to substantially increase infrastructure investment returns while at the same time addressing issues of falling infrastructure investment productivity of SOV based facilities.

Furthermore, by marrying these otherwise discrete travel markets and modes, i.e., transit and autos, some very useful travel-constituency partnerships can be created to advance a number of programs. With SOV users able to gain capacity expansion of highway mobility/accessibility corridors by partnering with transit users, not only is a new funding tool created to support regional highway and transit facility expansion, but a broadened consensus is created that better support the region's strategies for mobility advances, new institutional partnerships, innovative land use initiatives, e.g. smart growth, and transportation systems innovation.

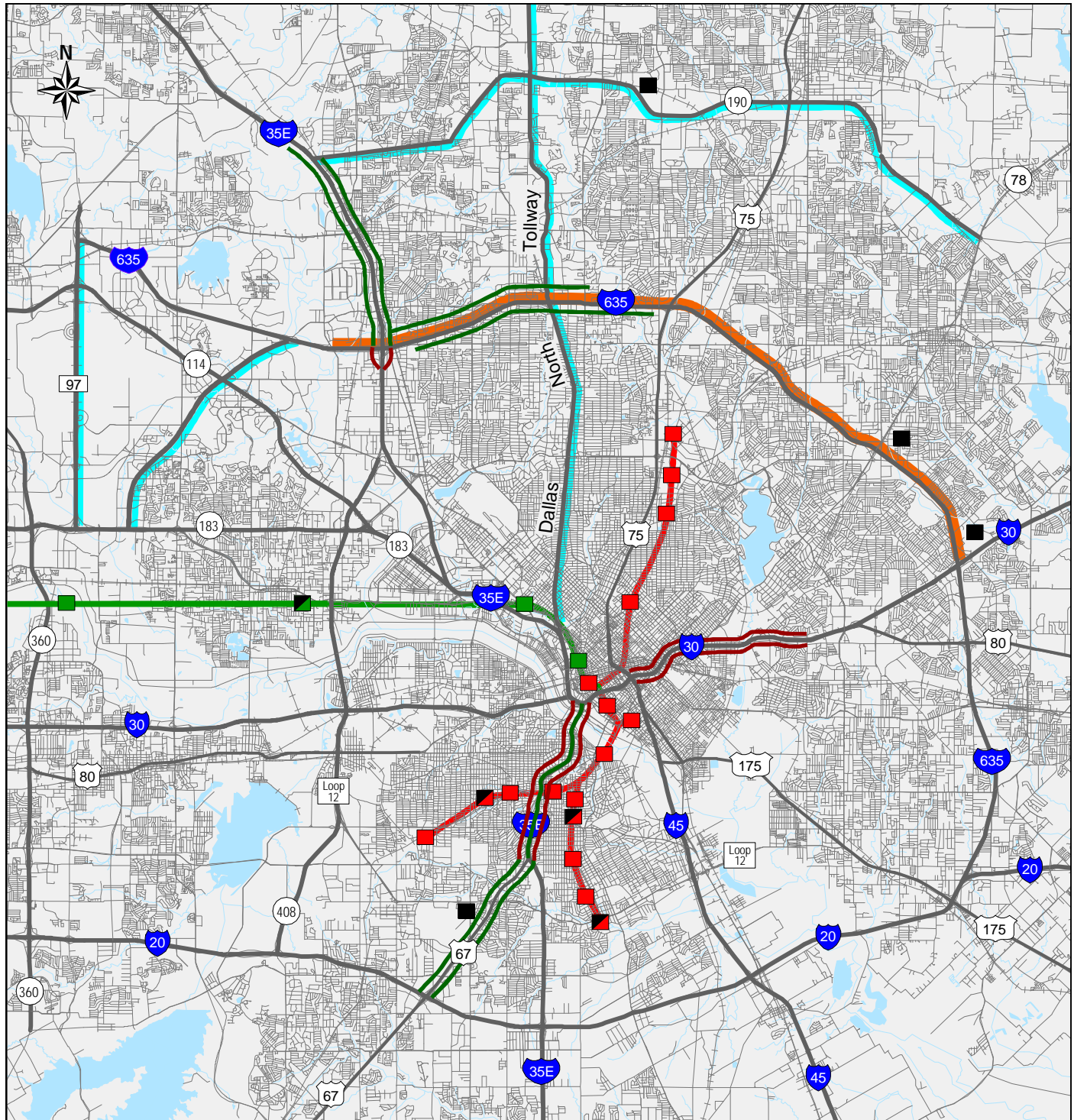
With these features potentially available, this report's assessment of operational characteristics is designed to assist the region's policymakers to identify a path to bring those benefits to the region's residents and businesses. In so doing, the region should be better able to utilize MLs to support:

- ✍ Transportation facility and services expansion;
- ✍ Regional economic efficiency;
- ✍ "Smart Growth", and
- ✍ Economic development.

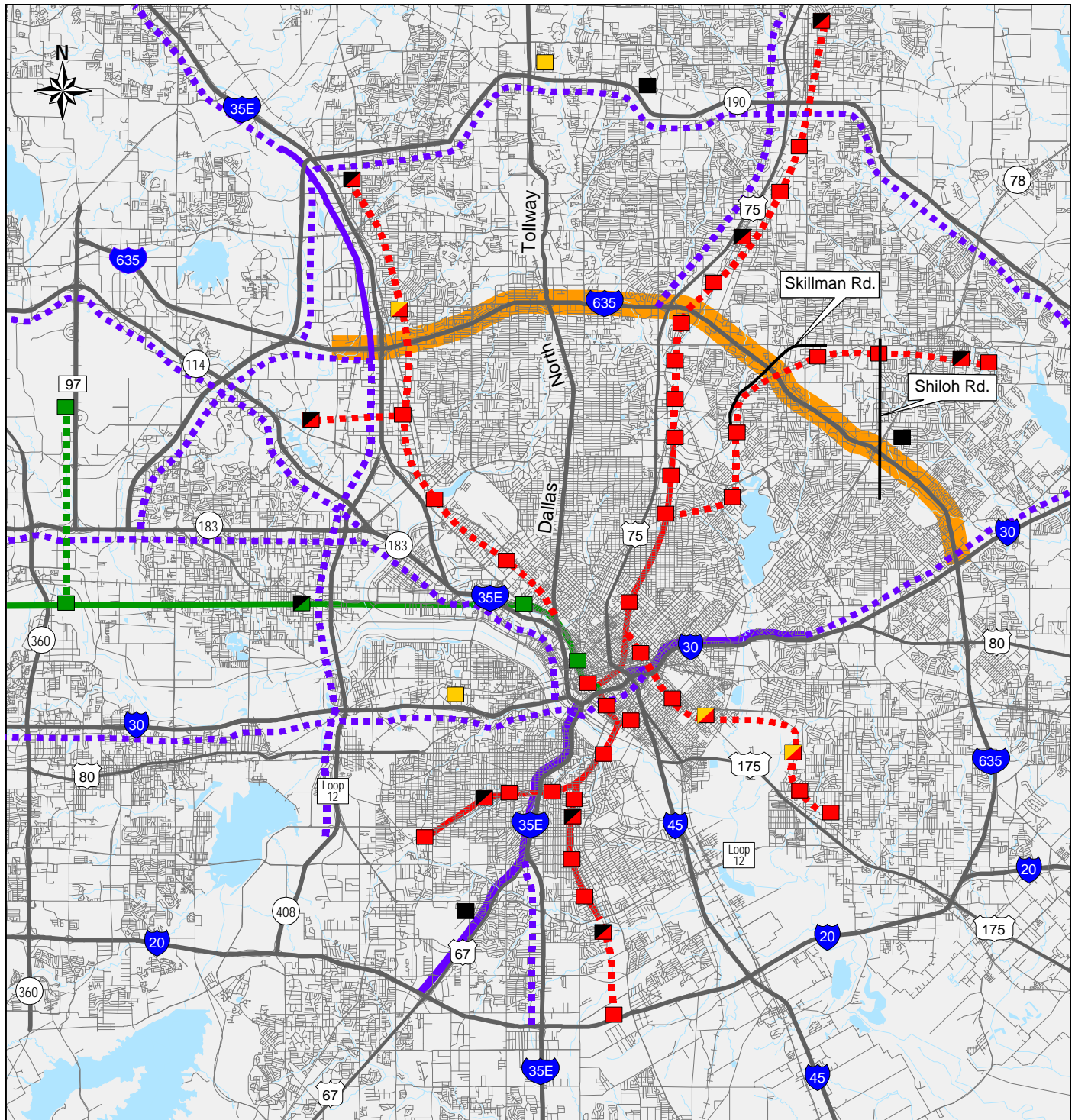
THE LBJ MANAGED LANES IN THE CONTEXT OF THE DALLAS REGION'S EVOLVING TRANSPORT NEEDS

While this report is focused on the LBJ Freeway, the region has identified a number of corridors where ML might be the best solution to their long-range transport needs. Figure 1-3, Major Regional Transport Facilities, 2001, shows the Dallas region as a region with all the components of a fully modern transport system. It includes an international airport, a regional/national airport, the interstate system, state provided freeways, toll facilities and inter-city, commuter and light rail lines and bus transit systems.

Figure 1-4, Planned Major Regional Transportation Facilities shows the regional transport system, as it could appear in 2015 should current plans

**LEGEND**

- | | |
|---------------------------|---------------------------------|
| LBJ Managed Lanes Project | Light Rail Starter System, 2000 |
| 24 Hour HOV Lanes | Light Rail Stations |
| Reversible HOV Lanes | Commuter Rail, 2000 |
| Tollway | Commuter Rail Stations |
| | Bus Transit Centers |
| | Major Highways |

**LEGEND**

- Light Rail Stations
- Commuter Rail Stations
- Bus Transit Centers
- Future Transit Centers
- LBJ Managed Lanes Project
- Light Rail Starter System, 2000
- ... Future Light Rail Extensions
- Commuter Rail, 2000
- Proposed Commuter Rail Extension
- Existing HOV Lanes
- ... Proposed HOV Lanes

come to fruition. This is the expected opening date for the substantially complete LBJML facility and the forecast planning horizon for this study, as noted earlier. In addition to the extensive facilities that exist in the year 2001, an extensive array of facility expansions are noted along with new facility construction.

As can be seen, in addition to the LBJML facility, several other facilities are noted as sites of potential future application of HOV lanes. These facilities can be seen as potential platforms for the ML transport concept.

If realized as presently designed, this ML network should bring some very innovative and operationally effective transport solutions to the Dallas region. As noted above, the new easier forms of payment embodied in the ETC systems, which will be incorporated into the LBJML facility, will allow for a more seamless mode of travel between non-charged and charged facilities. The added revenues from the tolled facilities should assist transport planners in bringing needed mobility expansion to the region far more quickly than previously anticipated.

Into this regional context, the LBJML facility is designed as the lynchpin of multi-modal enhanced regional mobility strategy. It not only ties the HOV/ML network effectively into the larger highway system, it will be the facility that most broadly connects the traveler to other modal choices, important regional destinations like the DFW Airport and other major employment centers.

In this role, given the region's adoption of transportation industry's latest technological capabilities, the facility user will be able to potentially access various mode choices in a seamless fashion. In so doing, the managers of those facilities will be able to make cross systems and cross mode discounts available to the transport system user in order to maximize the travel benefits available and maximize the regional transportation system's performance.

These benefits form the basis of locational competitive advantage and therefore should immediately be convertible into economic advantage in a growing region such as the Dallas region. By being able to provide a level of multi-modal, targeted accessibility to selected sites within a given transport corridor, MLs offer a real-estate-based value-creation capability that other transport platforms lack. This can be further accelerated through cooperative and reinforcing policies by other mobility and land use planning agencies. While these strategies and policies remain well beyond the realm of this study, for maximum benefit payout, MLs should be seen and understood within this framework.

BENEFITS ACHIEVABLE FROM THE PROPOSED ML BASED REGIONAL TRANSPORT NETWORK

ENHANCED REGIONAL MOBILITY

ML systems are the only transport system platform existing today and into the near-term future that can effectively meld the operational needs of SOVs, HOVs, Bus Rapid Transit (BRT), Light Duty Trucks (LDT) and Heavy Duty Trucks (HDT) into a continuously flowing mobility corridor. Because of its performance capabilities, it has the potential to become a widely accepted element in almost every interstate facility in the region where traffic system geometry and available Right of Way. It should be noted that because of the ability of MLs to blend the characteristics of several types of highway operations formats, it is possible to put these features in a blended format within MLs using far less land than one would ordinarily use to accommodate those same capabilities independently within one corridor.

At this regional level of adoption, the network of continuously operating mobility corridors would not only enhance general suburban mobility, but it would also fully integrate the Central Business District (CBD) and suburban multi-activity centers via a web of mobility that could include heavy duty rail, light duty rail, BRT, bus transit, tolled and non-tolled interstate level roadways.

This capability is implicit in the network of facilities that are planned and under construction in the region and which are shown in Figure 1-4.

MULTI-MODAL TRANSPORT SYSTEM INTEGRATION

Because of the necessity to use a convenient form of ETC to make real time variable tolling effective, the evolution toward Smart Card systems is most likely to be accelerated not only in the Dallas region but also throughout the nation. Smart Cards are credit-card looking payment devices that enable their users to pay for goods and services by directly deducting funds that are stored in an electronic chip that is embedded in the card. Much more information is capable of being stored on the imbedded chip which enables its users to be recognized for past purchases and uses and thereby qualify for discounts or other incentives.

Having the ability to continuously vary prices and keep track of system usage enables system operators to offer cross system discounts as a means of encouraging the use of the various elements of the region's transport system in a manner that provides the best travel times for the user and higher levels of efficiency and facility utilization for the system operators.

Real-time traffic flow information, upon which ML mobility and toll rates are predicated, will likely be generally available in the near term future for in vehicle use. This capability, when combined with today's vehicle location systems that provide real time location information and routing information, will enable tomorrow's drivers to alter their route as they approach some accident site or congestion area. This service, while adding convenience for the driver, adds system performance increases for the system managers, as well as, the follow-on increases in infrastructure investment returns that will accrue as a result of increasing overall system performance at no sizable increase in facility investment. This infrastructure investment performance increase in turn will lead to the region being able to support a greater level of economic activity with a given level of funding available for infrastructure facility construction/investment. This sort of performance improvement will make the Dallas region even more competitive on a global basis, as a place for doing business and more convenient for the business person and their families as a place to live and work.

SYSTEM AND CORRIDOR TRAVEL MODE BALANCING

Another by-product of the capabilities embedded in the use of ETC is the ability to balance the use of various modes through the tool of relative pricing and pricing incentives combined with the information technology capabilities that enable these prices to be disseminated throughout the marketplace. In the Dallas region, several highway systems are being planned and/or proposed as HOV and/or tolled facilities. In addition to the existing rail system, there is an extensive network of rail either planned or under construction. This expanded system will provide supplemental rail capacity within several important corridors in the region.

Through the use of cross-incentive pricing of commuter and light rail, bus transit, parking, and toll roads, it may be possible to move travelers into modes that they might not otherwise take in a generally un-priced road network. However, with the proposed ML network under consideration for the region is coupled to cross-incentive pricing for multi-modal use of the system over varying time periods, e.g., daily, weekly or monthly, transport system carrying capacity can be substantially improved/increased. With those improvements come the sharp increases in the return on infrastructure investment.

REVENUE DEVELOPMENT

Since MLs envisioned for the LBJ are to be tolled, they have the ability to supplement traditional federal and non-federal sources of public revenues to make system expansion more readily achievable at any given level of public funding availability. But beyond this, because of the nature of ML

to support BRT services and other forms of HOV services, these facilities have the potential to generate non-traditional revenue sources generally seen at rail-based facilities.

This type of return on investment in ML is achievable, because it can deliver higher levels of market access than either traditional toll roads or traditional non-tolled highway facilities, and market access determines land value potential, all other things being equal. Because of the complex nature of framework needed to create these returns, a far higher level of cooperation between the public and private sectors than is normally seen in transport system planning and development will be required if these returns are to be obtained.

TRANSPORT SYSTEM AND SERVICES PERFORMANCE INCREASES

The improvements in transportation system and services performance implicit/inherent in ML will only be achievable through very high levels of inter-agency and public/private cooperation. This is due not only to the need to evolve the various modal management systems but also to the need for a parallel evolution of both the systems operators' and the systems users' operational capabilities along a coordinated, compatible technology platform. However, the Dallas region is well on its way toward clearing that hurdle as a result of the formation of its regional transportation technology coordinating committee.

The work of this committee in bringing bus transit, Paratransit, rail, highway and parking systems along a compatible technology platform is well underway, and if they take advantage of the potentials that are within its grasp, the region's transport systems will be able to deliver a level of mobility, travel value, system performance, and return on investment not really seen in the field since the creation of the federal Interstate System. However, to reach the full potential of benefits available, broader involvement of the private sector and the traveling public will also need to be seen at the policy level as well. If this is accomplished, the system planners, operators and users should very substantially:

- ✍ Improve mobility;
- ✍ Increase the region's economic competitiveness;
- ✍ Increase quality of life;
- ✍ Increase the system safety; and
- ✍ Enhanced environmental performance from the regional transportation system.

CHAPTER 2

EXISTING TRAFFIC CONDITIONS

A major part of the effort involved in this phase of the project's development is the refinement of the analytical and methodological techniques used in understanding the travel demand, traffic flow and revenue generation characteristics of the proposed LBJML facility. To achieve these objectives, traditional measures of the existing LBJ facility operational characteristics need to be married to the latest travel simulation and forecasting techniques.

The reader will note that in compiling this data, we do not use it directly to propose the direction of capacity enhancement strategies or tolling regimes. This data is used to calibrate forecasting models. These calibrated models are then tied to future population levels and economic activity levels that are spatially distributed over the region. This socioeconomic picture of the region, configured for the forecast year of 2015, is used to determine future levels of activity on several alternate proposed design configurations of the LBJML facility, itself located within a largely recast transport network. This resultant travel activity is then used by the WSA team to forecast travel on various configurations of the LBJML at various toll rates.

This chapter describes the collection of data used to characterize the operational performance of the existing facility and the supporting network associated with it. This data was used to calibrate the models so that a more accurate representation of the proposed facility's travel and revenue performance could be developed.

The specific data collected for this LBJML Preliminary Feasibility Phase II Study are hourly traffic volumes, selected intersection counts (some including turning movements) and travel speed data on the LBJ Freeway and on parallel corridors. This data was being combined with vehicle occupancy data from the Phase I Study. The vehicle occupancy data will be included in this chapter even though it was collected in the previous study effort in order to have a complete data set available to the reader of

this report. Special note should be made that this study utilized the same levels of HOV usage as was proposed for use in the Phase I study.

LBJ TRAFFIC DATA COLLECTION PLAN

To develop the traffic volume data needed for this study, an extensive set of traffic count locations was identified at critical locations in the LBJ corridor, these included:

- ✍ Ramps to the LBJ general purpose (GP) lanes;
- ✍ Access points for the LBJ HOV lanes;
- ✍ Frontage road locations;
- ✍ LBJ GP lane locations; and
- ✍ Parallel facilities that represent competing corridors.

Specific classes and numbers of traffic counting sites selected for inclusion in the study are listed below:

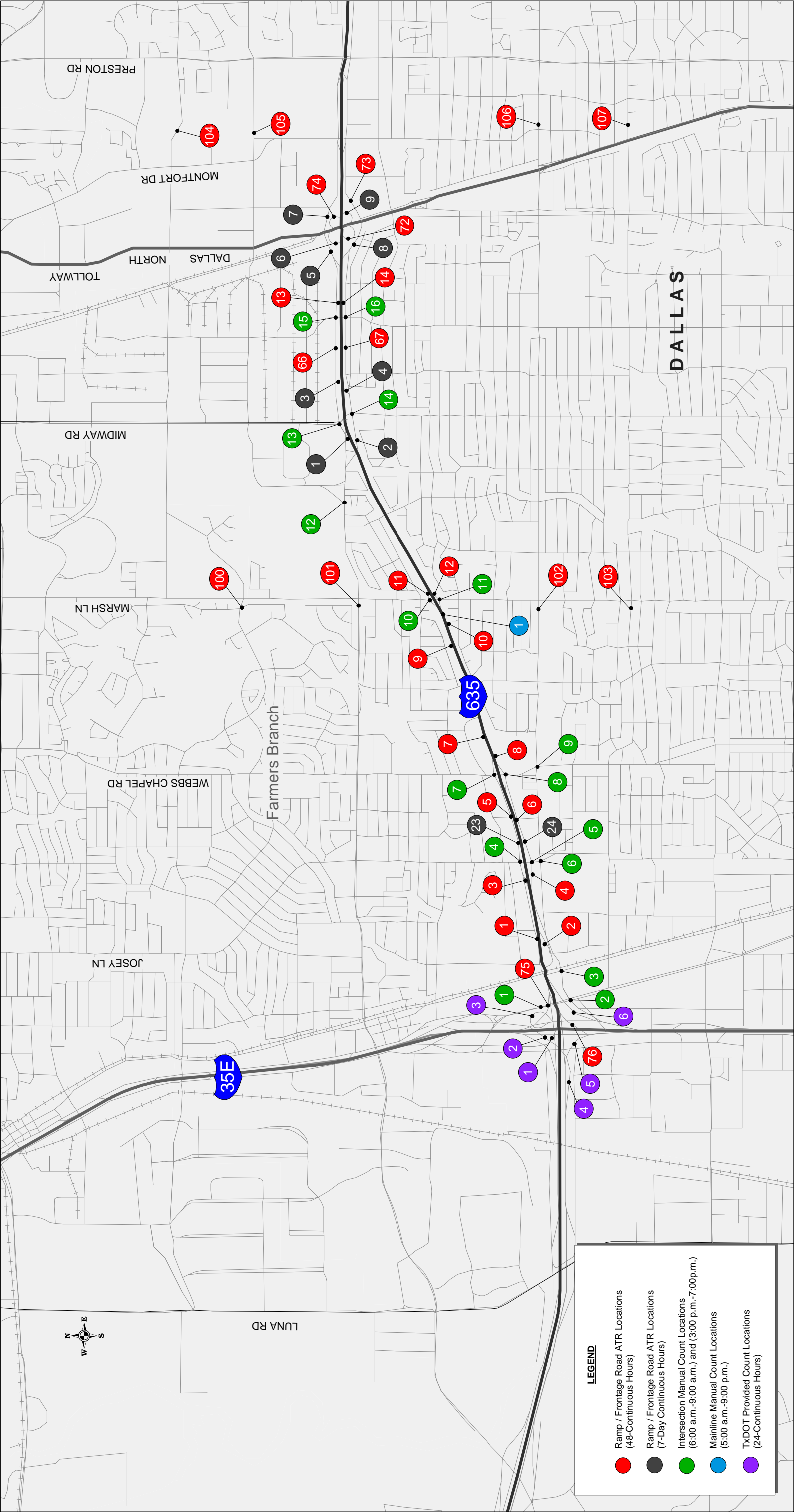
- ✍ 90 ramp and frontage road locations for 48-hour continuous counts;
- ✍ 26 ramp and frontage road locations for seven day continuous counts;
- ✍ 60 intersections for manual counts between 6:00 to 9:00 a.m. and 5:00 to 7:00 p.m.; and
- ✍ 4 main lane locations for manual counts between 5:00 a.m. to 9:00 p.m.;

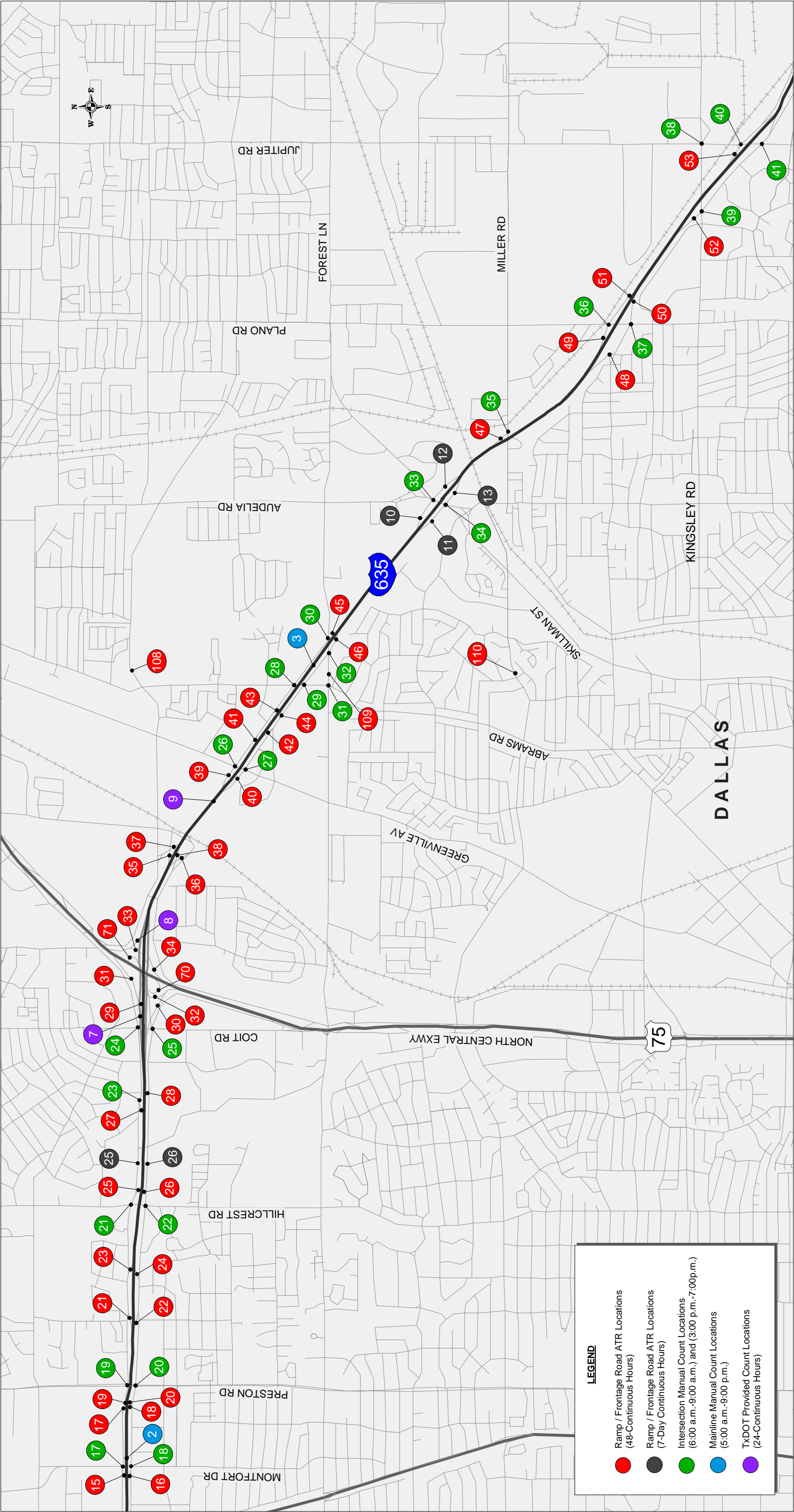
Figure 2-1, Traffic Count Locations, identifies the locations of all the traffic count sites by type of data collected:

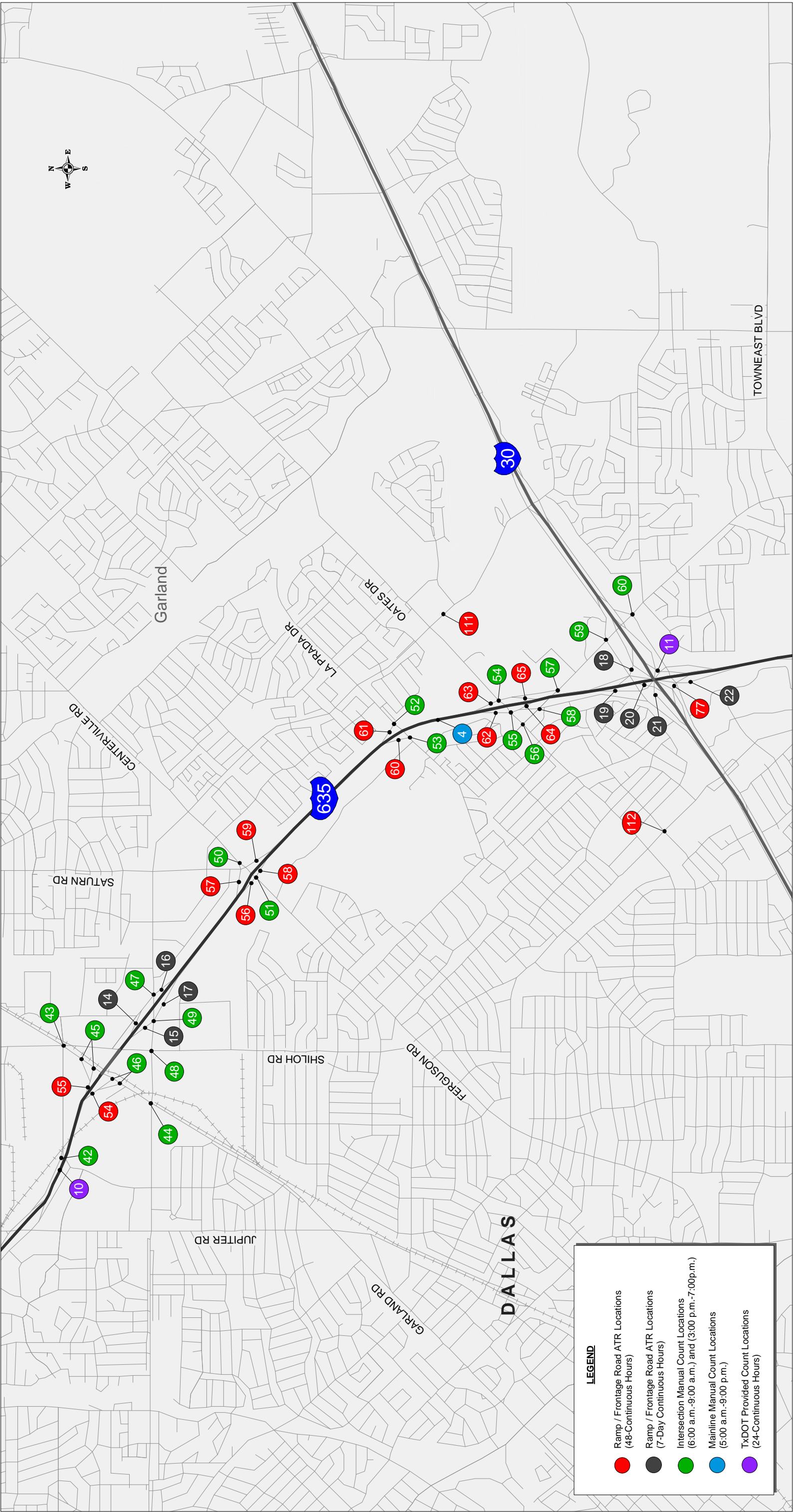
- ✍ 48-hour, continuous;
- ✍ 7-day, continuous;
- ✍ Intersection, manual, peak period;
- ✍ GP lanes, manual, 5:00 a.m.– 9:00 p.m.; and
- ✍ TxDOT data, 24-hour, continuous.

The traffic count data collected from these means showed some anomalies that were corrected through reference to, and use of, the traffic count data collected by the NCTCOG in 1999.

Traffic counts were compiled during the months of October and November 2000. The count sites represent all exit and entrance ramps along the study segment. Counts were also collected at the intersections of







several parallel arterial streets. Frontage road sites as well as sites in the GP lanes of the LBJ Freeway were also included in the data collection effort.

Additional counts were obtained from TxDOT on seven exit and entrance ramps at I.H.-35, three GP lane locations, and one exit ramp to U.S. 75. Refer to Appendix A for a complete listing of traffic count locations.

LBJ TRAFFIC VOLUME DATA

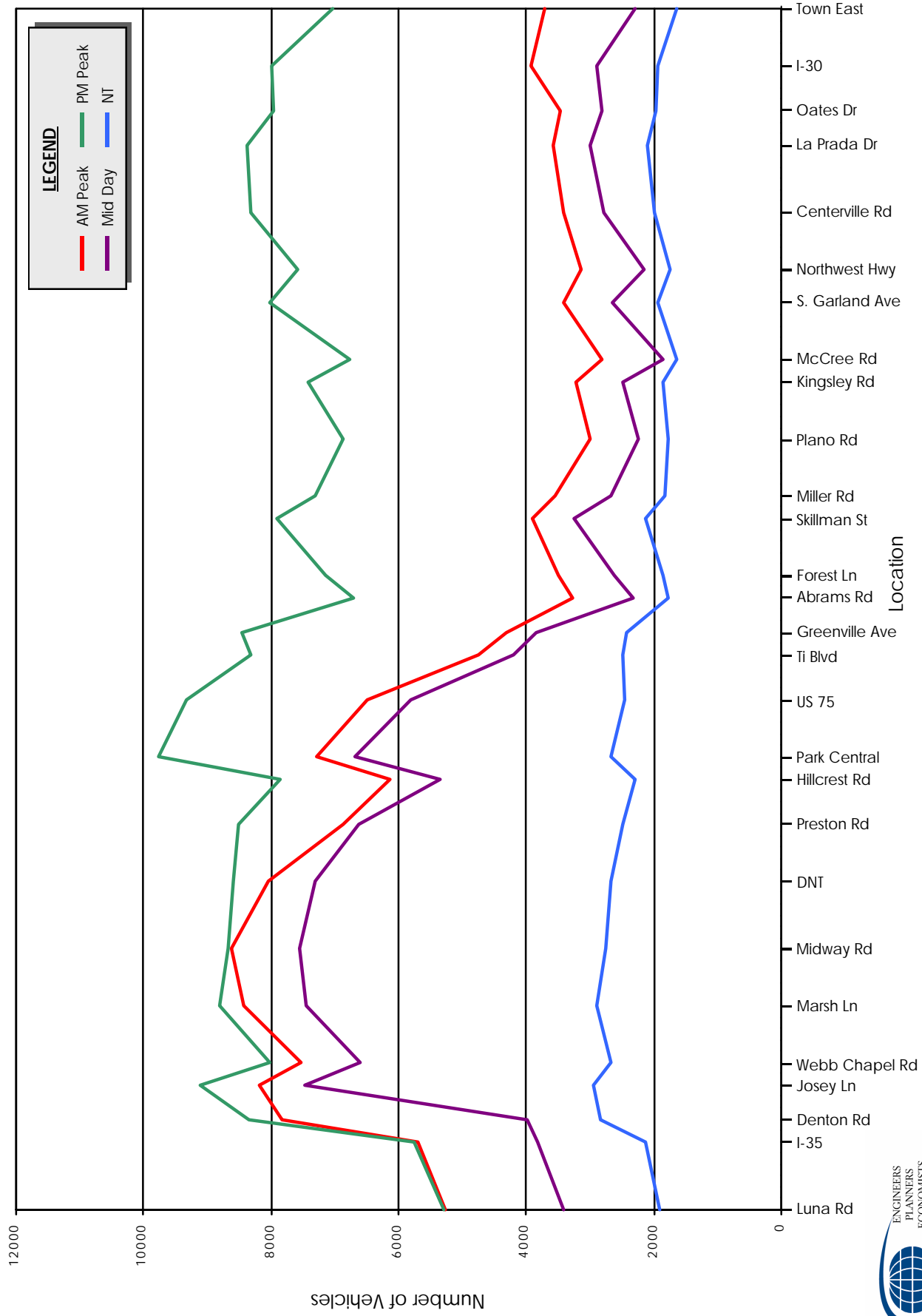
Figures 2-2 and 2-3 provide a summary on the balanced weekday average hourly traffic by period for each respective travel direction. The average hourly volume is obtained by averaging the total counts by the number of hours represented in each period. The travel periods are defined as covering the hours of:

- ✍ A.M. (6:00–9:00 a.m.);
- ✍ Midday (9:00 a.m.–3:00 p.m.);
- ✍ P.M. (3:00–7:00 p.m.); and
- ✍ Nighttime (7:00 p.m.–6:00 a.m.).

The highest traffic volumes are recorded between I.H.-35E and U.S. 75 for both eastbound and westbound travel in all four travel periods. In the eastbound direction, a sharp increase in travel occurs on the LBJ Freeway after the I.H.-35 Interchange. There is similar travel behavior in the westbound direction where heavy traffic volumes concentrate between U.S. 75 and I.H.-35E. West of I.H.-35E, on the westbound side, there is a substantial decrease in travel on the LBJ Freeway at the point between the respective exists and entrances as a result of traffic exiting onto I.H.-35E.

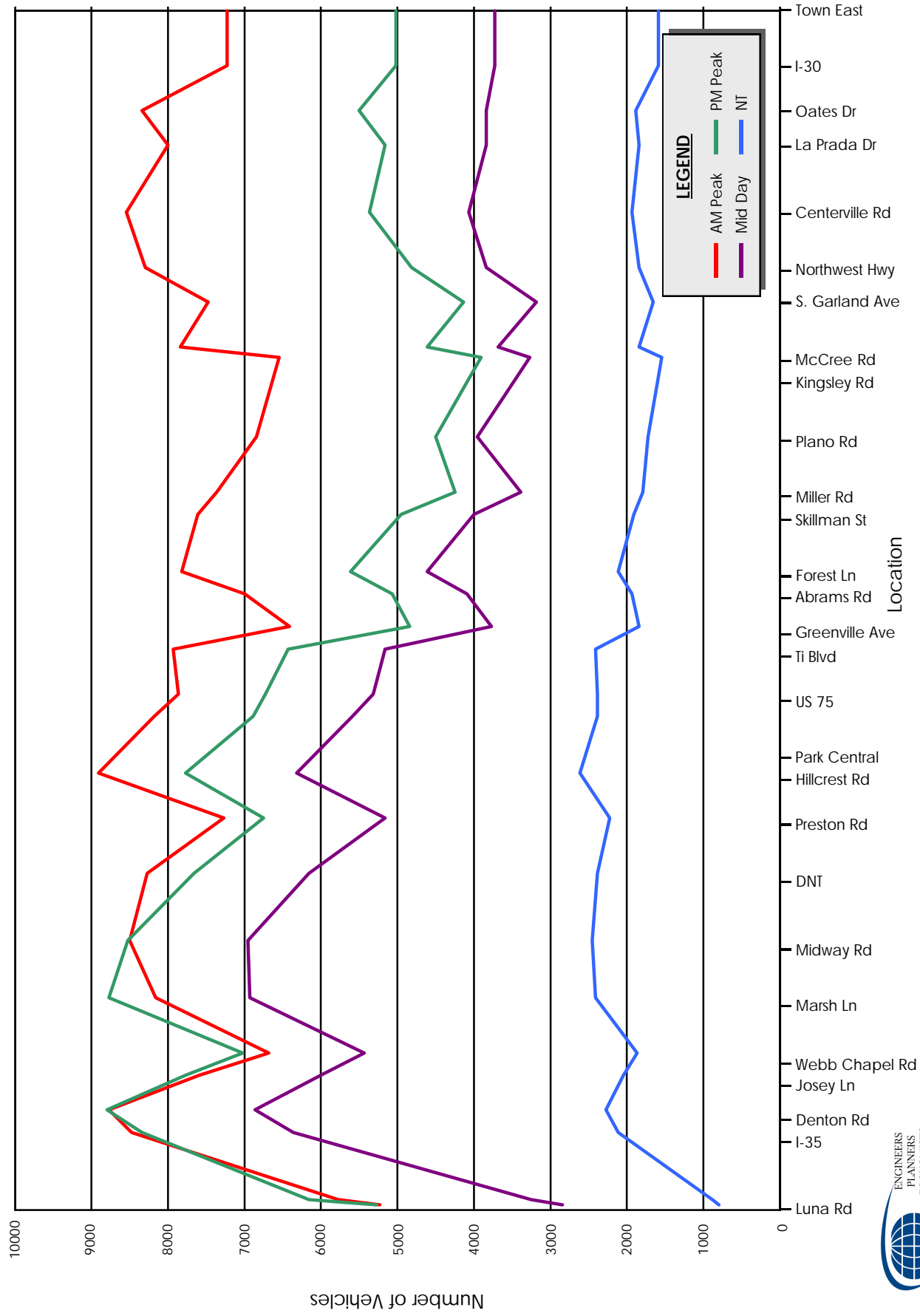
As one might expect, there are similar declines in traffic at the exits, which lead to the major interchanges for the Dallas North Tollway (DNT) and U.S. 75. Correspondingly, there is a sharp increase in traffic registered in traffic volumes on the entrances from these facilities onto the LBJ Freeway.

As Figure 2-2 shows in the P.M. peak period eastbound direction, traffic volumes remain relatively high all along the LBJ Freeway study segment. In the eastbound direction, in the vicinity of Luna to Preston Roads, hourly volumes of A.M., Midday, and P.M. time periods are within a 1,000 vehicles per hour difference. However, in the P.M. peak period eastbound direction, after the interchange at U.S. 75, the traffic volumes remain high, averaging between 6,000 to 8,000 vehicles per hour. A.M. and midday



LBJ GP LANES, EASTBOUND WEEKDAY AVERAGE HOURLY TRAFFIC BY PERIOD

FIGURE 2-2



LBJ GP LANES, WESTBOUND WEEKDAY AVERAGE HOURLY TRAFFIC BY PERIOD

FIGURE 2-3

average hourly traffic flow lowers to 3,000 vehicles per hour. Nighttime period traffic volumes remain low and steady in both directions.

In the westbound direction, A.M. peak travel volumes are shown to vary widely between 3,000 to 8,000 vehicles per hour over the entire length. The midday and P.M. traffic volume flow shows a similar level but are separated by approximately 1,000 vehicles per hour. The P.M. peak traffic varies from 5,000 vehicles per hour in the vicinity of Town East to a high of 8,000 vehicles per hour near I-35. Midday volumes follow a similar pattern but are approximately 1,000 vehicles less throughout the length of the study segment. Nighttime period volumes are relatively flat at about 2,000 vehicles per hour throughout the LBJ Freeway.

DAILY TRAFFIC VARIATIONS

Table 2-1, Daily Traffic Variations, shows the data collected at selected ramps at which 7-day Continuous Counts were undertaken. Ramps were selected from the set of 7-day count locations based on the travel at the ramps being typical of the travel behavior in the section of the roadway from which they were selected.

The data shown in Table 2-1 represents an average of traffic at a pair of ramps over the day shown. One can refer to Figure 2-1 to identify the specific location for each of the ramp pairs used to create the daily average traffic level shown in Table 2-1. For the column identified as:

| | |
|-----------------------------|---------------------------------|
| ✍ Ramps West of Midway Rd., | Ramps 1 and 2 (shown in orange) |
| ✍ Ramps West of DNT, | Ramps 5 and 8 (shown in orange) |
| ✍ Ramps East of Audelia Rd. | Ramps 12 & 13 (shown in orange) |
| ✍ Ramps East of the NW Hwy | Ramps 16 & 17 (shown in orange) |
| were used. | |

This data collection regime allows for the representation of average daily travel activity over the length of the facility at selected sites. The traffic volumes shown vary from a low daily level of traffic of 15,600 vehicles at selected ramps east of Audelia to a high of 34,700 vehicles per day on selected ramps east of the NW Highway. This figure appears to be well higher than what might be expected, but checks of the data collection procedures did not offer clues as to the reason for this high figure. Thursday is seen to be the highest daily travel day for all selected ramps given the index measure for the collected data of approximately 110 percent of the average day for all ramps on Thursday. Sunday, quite expectedly, shows the low travel day with an index varying from 60 to 80 percent of the average day for all selected sites. Mondays and

Table 2-1
Daily Traffic Variations
Selected LBJ Frontage Ramps*

| Day | Ramps 1 & 2 West of Midway Road | Ramps 5 & 6 West of DNT | Ramps 12 & 13 East of Skillman/Audelia Road | Ramps 16 & 17 East of NW Highway |
|---|--|--|--|---|
| Monday | 31,297 | 22,079 | 15,706 | 35,166 |
| Tuesday | 30,528 | 22,407 | 15,628 | 36,002 |
| Wednesday | 30,748 | 24,091 | 15,297 | 36,371 |
| Thursday | 32,358 | 24,713 | 16,424 | 37,421 |
| Friday | 31,305 | 26,622 | 15,980 | 38,858 |
| Saturday | 23,593 | 19,324 | 17,441 | 33,419 |
| Sunday | <u>16,206</u> | <u>14,389</u> | <u>12,874</u> | <u>25,955</u> |
| TOTAL | 196,035 | 153,625 | 109,350 | 243,192 |
| Average Daily | 28,005 | 21,946 | 15,621 | 34,742 |
| PERCENT OF AVERAGE DAILY (INDEX) | | | | |
| Monday | 111.8 | 100.6 | 100.5 | 101.2 |
| Tuesday | 109.0 | 102.1 | 100.0 | 103.6 |
| Wednesday | 109.8 | 109.8 | 97.9 | 104.7 |
| Thursday | 115.5 | 112.6 | 105.1 | 107.7 |
| Friday | 111.8 | 121.3 | 102.3 | 111.8 |
| Saturday | 84.2 | 88.1 | 111.6 | 96.2 |
| Sunday | 57.9 | 65.6 | 82.4 | 74.7 |
| Average Day | 100.0 | 100.0 | 100.0 | 100.0 |

* See Figure 2-1 for locations of ramps by number.

Tuesdays are close competitors for the lowest, weekday travel-activity day.

VEHICLE CLASSIFICATION DISTRIBUTION

Table 2-2, Vehicle Class Distribution, shows the composition of traffic at four selected sites by travel period. Interestingly, the midday period shows the highest levels of auto use. The same is true for LDT and HDT except for the Marsh Road site, where the A.M. peak edges out the midday period for the LDT high-use period. When viewed from the perspective of vehicle composition on the facility during the three main travel periods, A.M., Midday and P.M. periods, autos reach their highest use during the P.M. period when they comprise roughly 94 percent of the traffic.

Truck use is generally highest during the midday period. However, the LBJ Freeway has relatively low levels of truck use when compared to other heavy truck corridors in the region.

CURRENT LBJ FREEWAY TRAVEL SPEEDS

Speed and delay runs were conducted along the LBJ study-area segment during the A.M. period from 6:00 until 10:00 a.m. In the P.M. period, data was collected from 2:00 through 7:00 p.m. This data was collected October 25 and 26, 2000.

Speed and delay runs on six competing parallel arterials were also carried out during the A.M. and P.M. periods on October 13, October 16-19, and November 6-8, 2000.

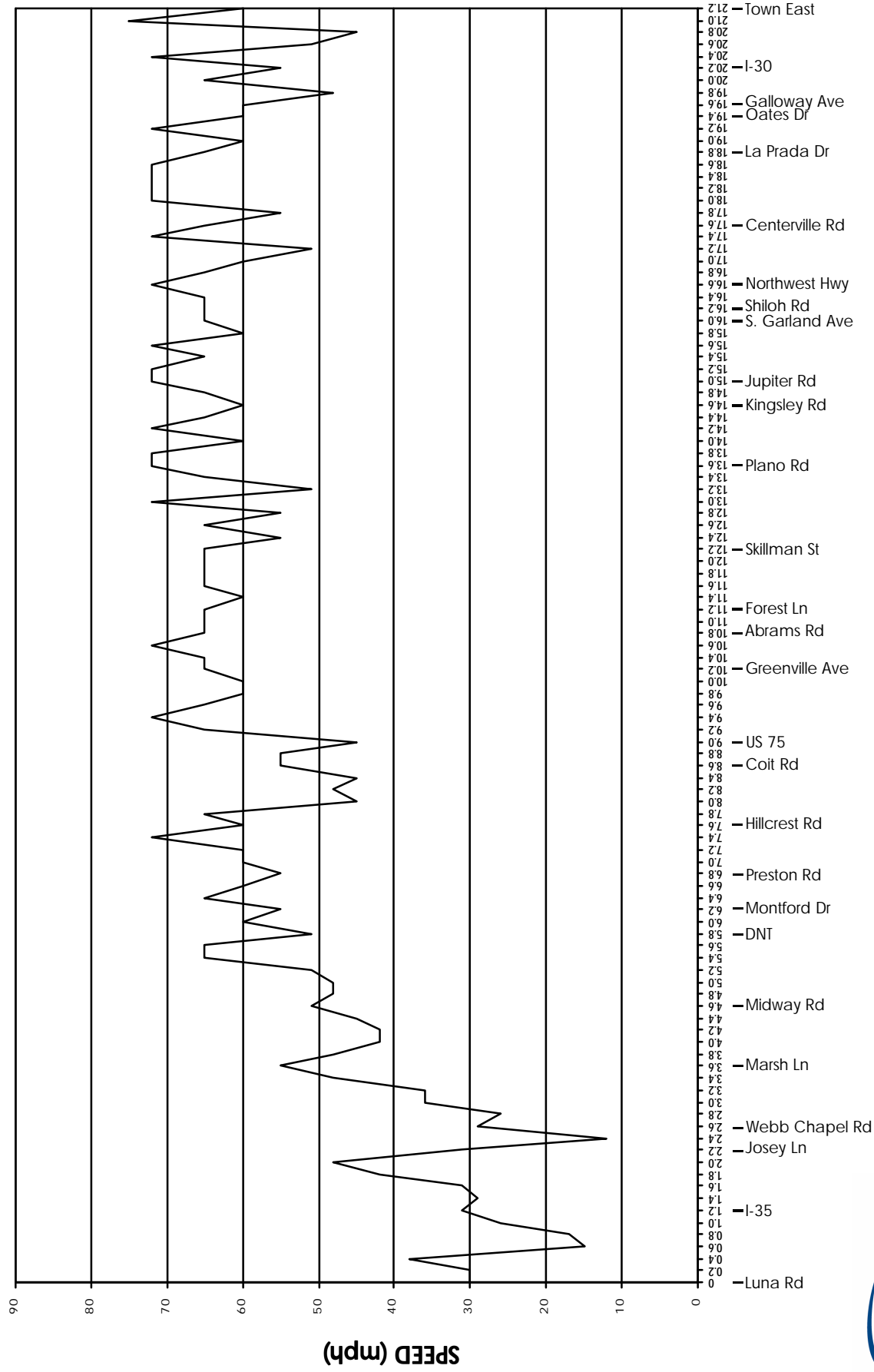
Figures 2-4 to 2-7 illustrate the data collected on the speed/delay runs by direction and period. It is compiled as travel speed versus distance on the LBJ general-purpose lanes in the A.M. and P.M. travel periods in both directions. The runs shown in Figures 2-4 through 2-7 were selected from total data collected to best represent a typical weekday condition.

In the eastbound A.M. period, travel speed along I.H.-35 to DNT is relatively low, i.e., between 13 to 50 mph. After the DNT Interchange, speed increases to 50 to 70 mph, and then there is a slight drop in speed in the vicinity of Interchange U.S. 75 to 45 mph. Over the balance of the corridor, speed is maintained between 50 to 70 mph.

In the eastbound P.M. peak, the travel speed is much lower than the A.M. peak period. Between I.H.-35 and U.S. 75, the travel speed is between 10 to 45 mph. After U.S. 75, there is a gradual increase in travel speed to 70

Table 2-2
Vehicle Class Distribution

| Location/Period | Passenger Cars | Average Hourly | Light Trucks | Average Hourly | Heavy Trucks | Average Hourly | Total | Average Hourly | Time Period | | | |
|-------------------------------|-------------------|-------------------|-----------------|-------------------|-----------------|-------------------|--------|-------------------|-------------------|-----------------|-----------------|-------|
| | | | | | | | | | Passenger Cars | Light Trucks | Heavy Trucks | Total |
| | | | | | | | | | | | | |
| 1. MARSH LN | | | | | | | | | | | | |
| AM Peak | 39,395 | 13,132 | 5,403 | 1,801 | 1,807 | 602 | 46,605 | 15,535 | 84.53% | 11.59% | 3.88% | 100% |
| Midday | 86,773 | 14,462 | 4,715 | 786 | 3,896 | 649 | 95,384 | 15,897 | 90.97% | 4.94% | 4.08% | 100% |
| PM Peak | 51,958 | 12,990 | 1,904 | 476 | 1,997 | 499 | 55,859 | 13,965 | 93.02% | 3.41% | 3.58% | 100% |
| Others | 30,049 | 2,732 | 1,242 | 113 | 1,212 | 110 | 32,503 | 2,955 | 92.45% | 3.82% | 3.73% | 100% |
| 2. MONTFORT DR | | | | | | | | | | | | |
| AM Peak | 44,606 | 14,869 | 1,239 | 413 | 1,183 | 394 | 47,028 | 15,676 | 94.85% | 2.63% | 2.52% | 100% |
| Midday | 90,495 | 15,083 | 3,483 | 581 | 4,012 | 669 | 97,990 | 16,332 | 92.35% | 3.55% | 4.09% | 100% |
| PM Peak | 60,154 | 15,039 | 993 | 248 | 1,594 | 399 | 62,741 | 15,685 | 95.88% | 1.58% | 2.54% | 100% |
| Others | 34,651 | 3,150 | 292 | 27 | 1,052 | 96 | 35,995 | 3,272 | 96.27% | 0.81% | 2.92% | 100% |
| 3. ABRAMS RD-FOREST LN | | | | | | | | | | | | |
| AM Peak | 27,663 | 9,221 | 703 | 234 | 1,143 | 381 | 29,509 | 9,836 | 93.74% | 2.38% | 3.87% | 100% |
| Midday | 52,489 | 8,748 | 2,732 | 455 | 3,570 | 595 | 58,791 | 9,799 | 89.28% | 4.65% | 6.07% | 100% |
| PM Peak | 45,256 | 11,314 | 1,319 | 330 | 1,419 | 355 | 47,994 | 11,999 | 94.30% | 2.75% | 2.96% | 100% |
| Others | 19,722 | 1,793 | 479 | 44 | 973 | 88 | 21,174 | 1,925 | 93.14% | 2.26% | 4.60% | 100% |
| 4. LA PRADA LN | | | | | | | | | | | | |
| AM Peak | 24,136 | 8,045 | 846 | 282 | 1,225 | 408 | 26,207 | 8,736 | 92.10% | 3.23% | 4.67% | 100% |
| Midday | 51,864 | 8,644 | 2,592 | 432 | 3,678 | 613 | 58,134 | 9,689 | 89.21% | 4.46% | 6.33% | 100% |
| PM Peak | 50,046 | 12,512 | 1,510 | 378 | 1,838 | 460 | 53,394 | 13,349 | 93.73% | 2.83% | 3.44% | 100% |
| Others | 21,477 | 1,952 | 486 | 44 | 1,045 | 95 | 23,008 | 2,092 | 93.35% | 2.11% | 4.54% | 100% |



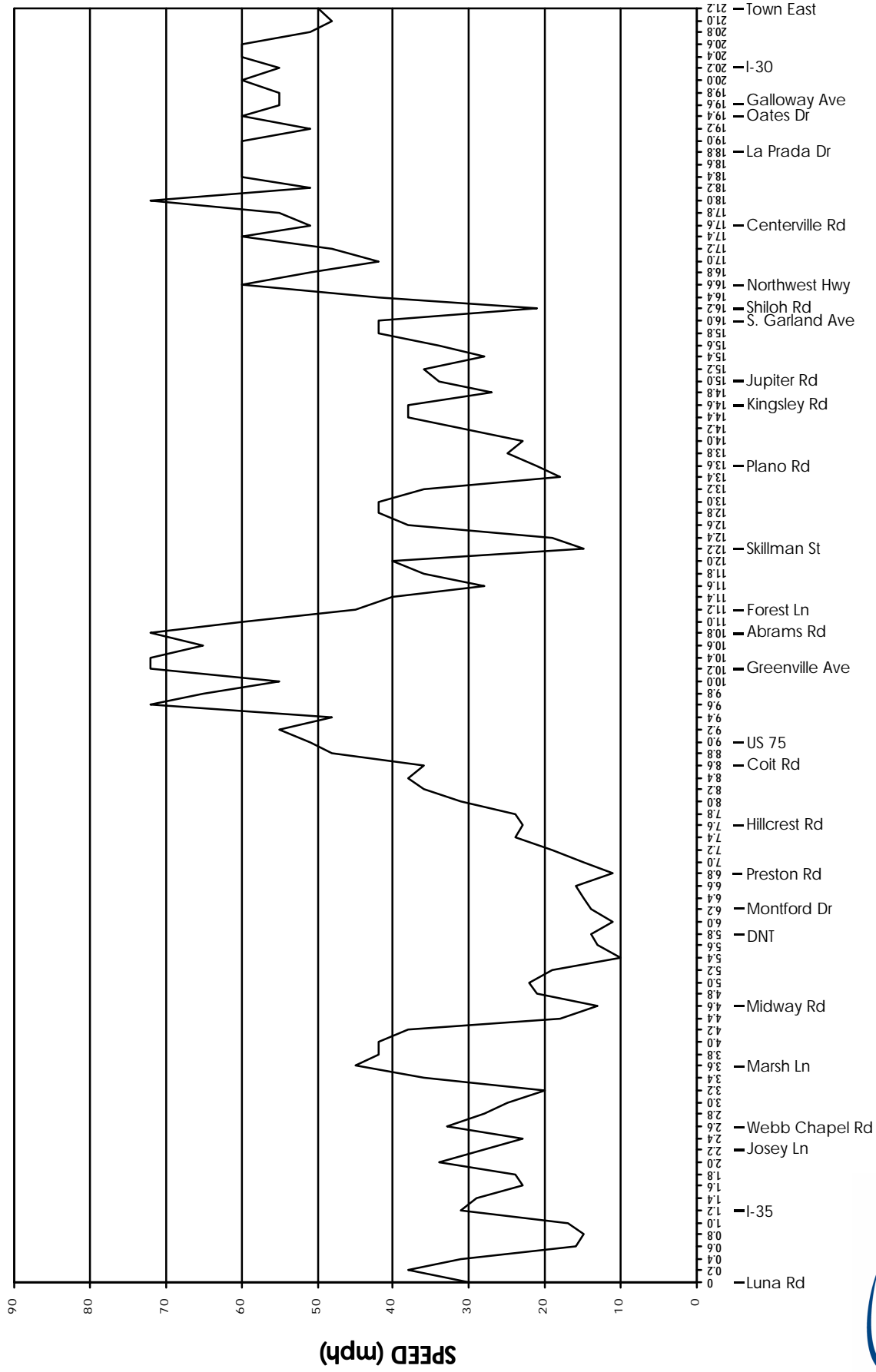
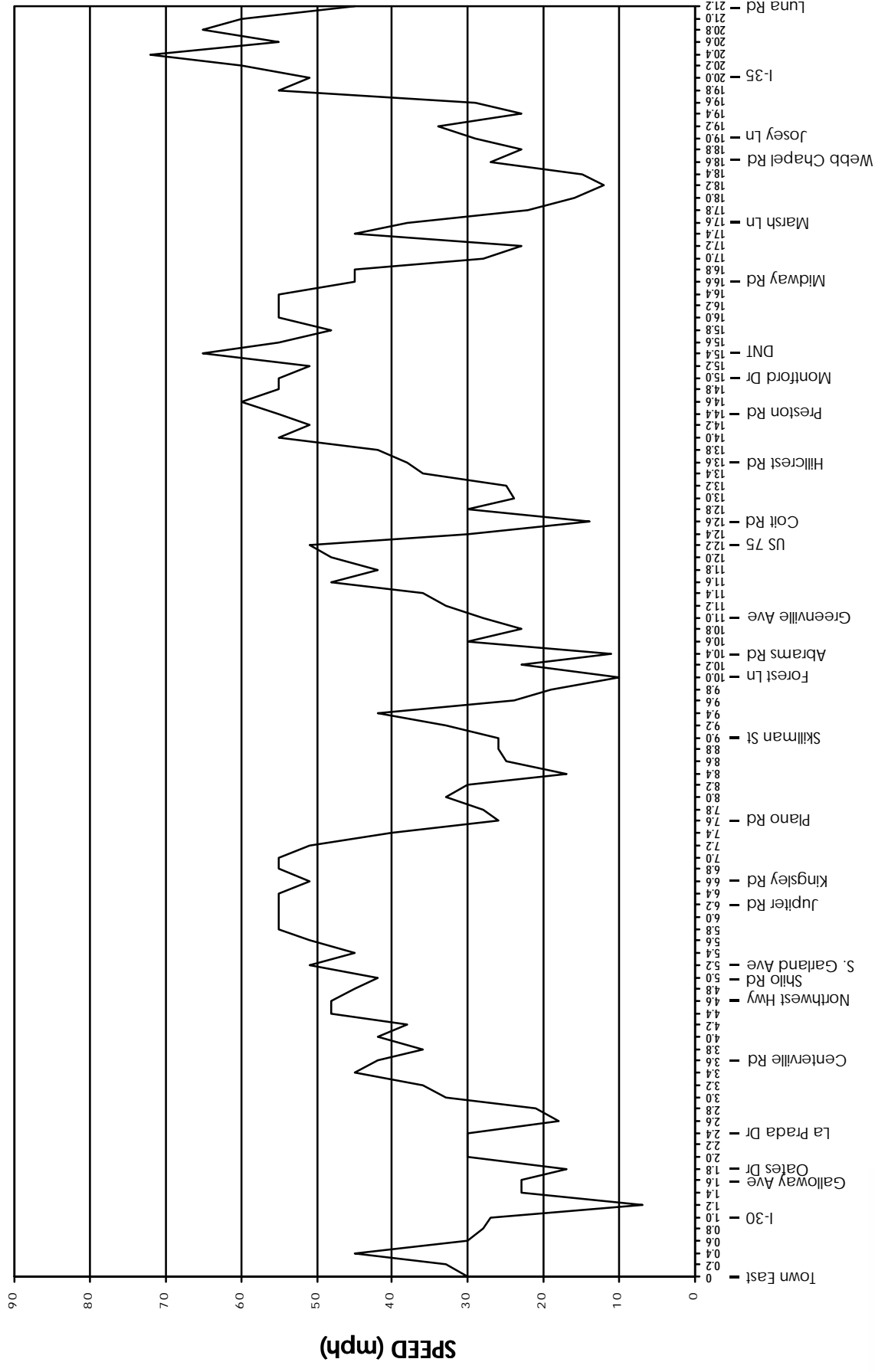
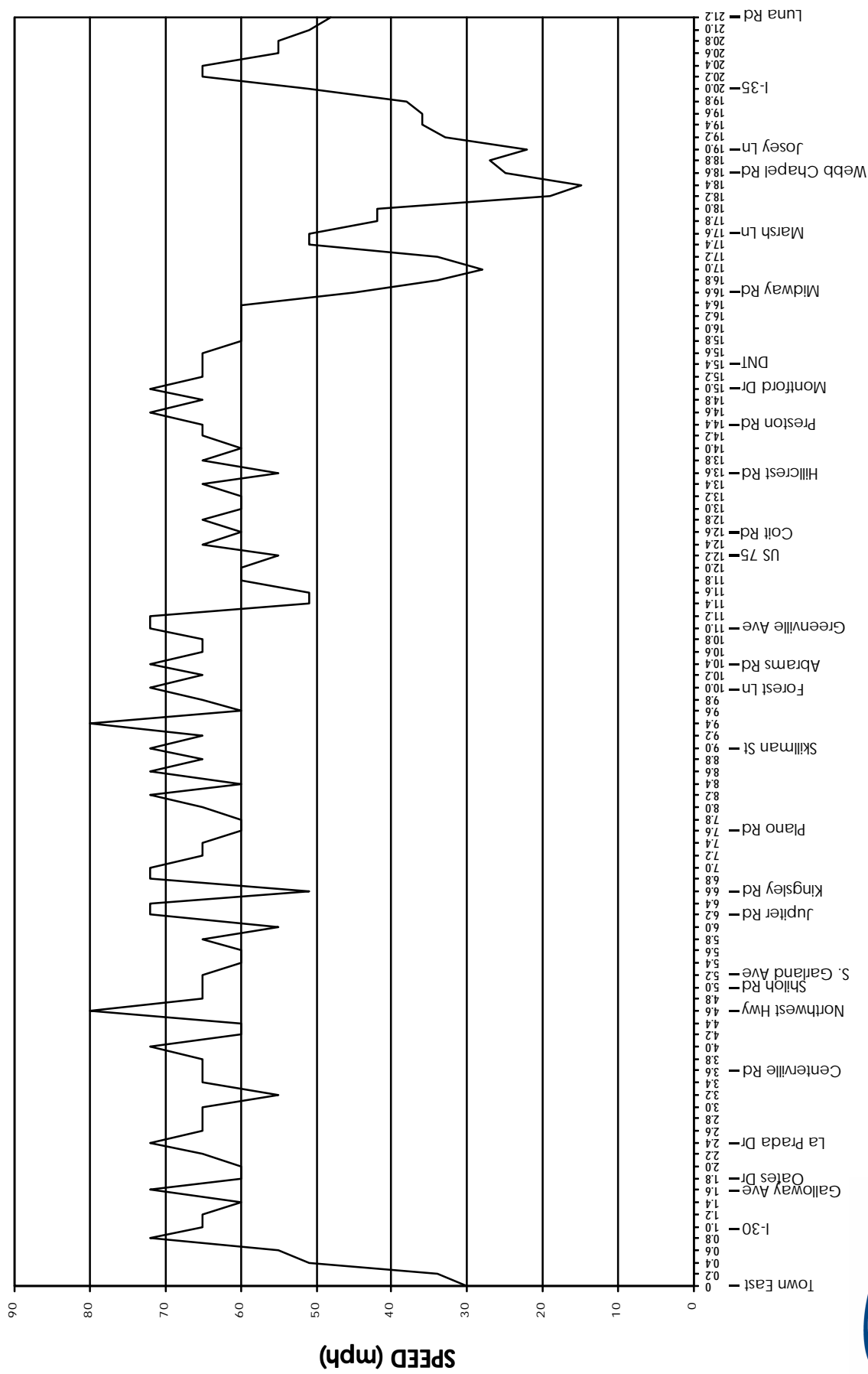


FIGURE 2-5



**OBSERVED LBJ GP LANE TRAVEL SPEEDS
WESTBOUND AM PEAK PERIOD**



OBSERVED LBJ GP LANE TRAVEL SPEEDS
WESTBOUND PM PEAK PERIOD

FIGURE 2-7

mph. Traffic slows to 15 to 40 mph between Abrams Road and Northwest Highway. Then the speed levels out to between 50 to 60 mph through the end of the study segment. Overall, the eastbound p.m. peak displays a more congested traffic pattern and a lower travel speed than the eastbound a.m. peak period.

In the westbound direction, the a.m. peak period has a much slower travel speed than the p.m. peak period. At many of the interchanges, e.g., I.H.-30, Abrams Road, U.S. 75, and Webb Chapel Road, the travel speed drops to as low as 10 mph. There are several short sections where travel speeds of more than 50 mph are experienced, e.g., between Josey Road and Plano Road, Hillcrest Road and Midway Road, and after I.H. 35.

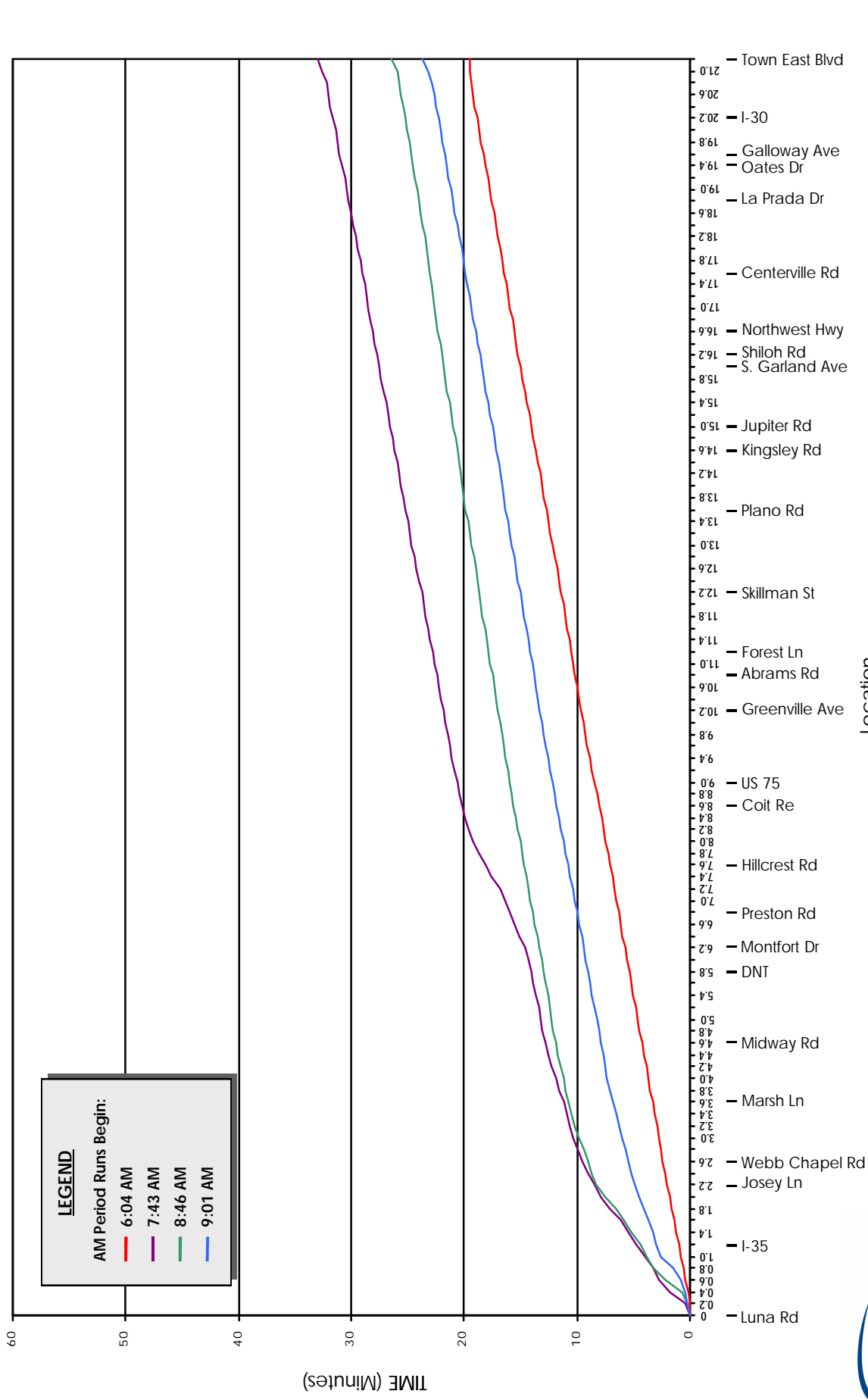
In the P.M. peak period, the speed is relatively steady. Between I.H. 30 to DNT, the typical speed is between 50 to 70 mph. After DNT before entrances and exists onto I.H. 35, speed decreases to between 15 to 50 mph. After the I.H.-35 Interchange, travel speed returns to approximately 60 mph.

Figures 2-8 to 2-11 illustrate the speed and delay runs in a time versus distance relationship. The runs shown were selected to represent the typical characteristics of the a.m. and p.m. travel periods. The A.M. westbound and p.m. eastbound direction requires a travel time between 20 to 54 minutes to travel between Luna Road to Town East Boulevard. Yet during the A.M. eastbound and P.M. westbound direction, the average travel time is between 19 to 33 minutes.

In the eastbound direction during the a.m. time period, the travel runs shown all display a substantial increase in travel time after the IH-35 Interchange, indicating a slowdown in speeds. For the run made at 7:43 a.m. there is a substantial jump in travel time at Preston Road, but for the remaining runs there is just a steady increase in travel time as one moves across the corridor.

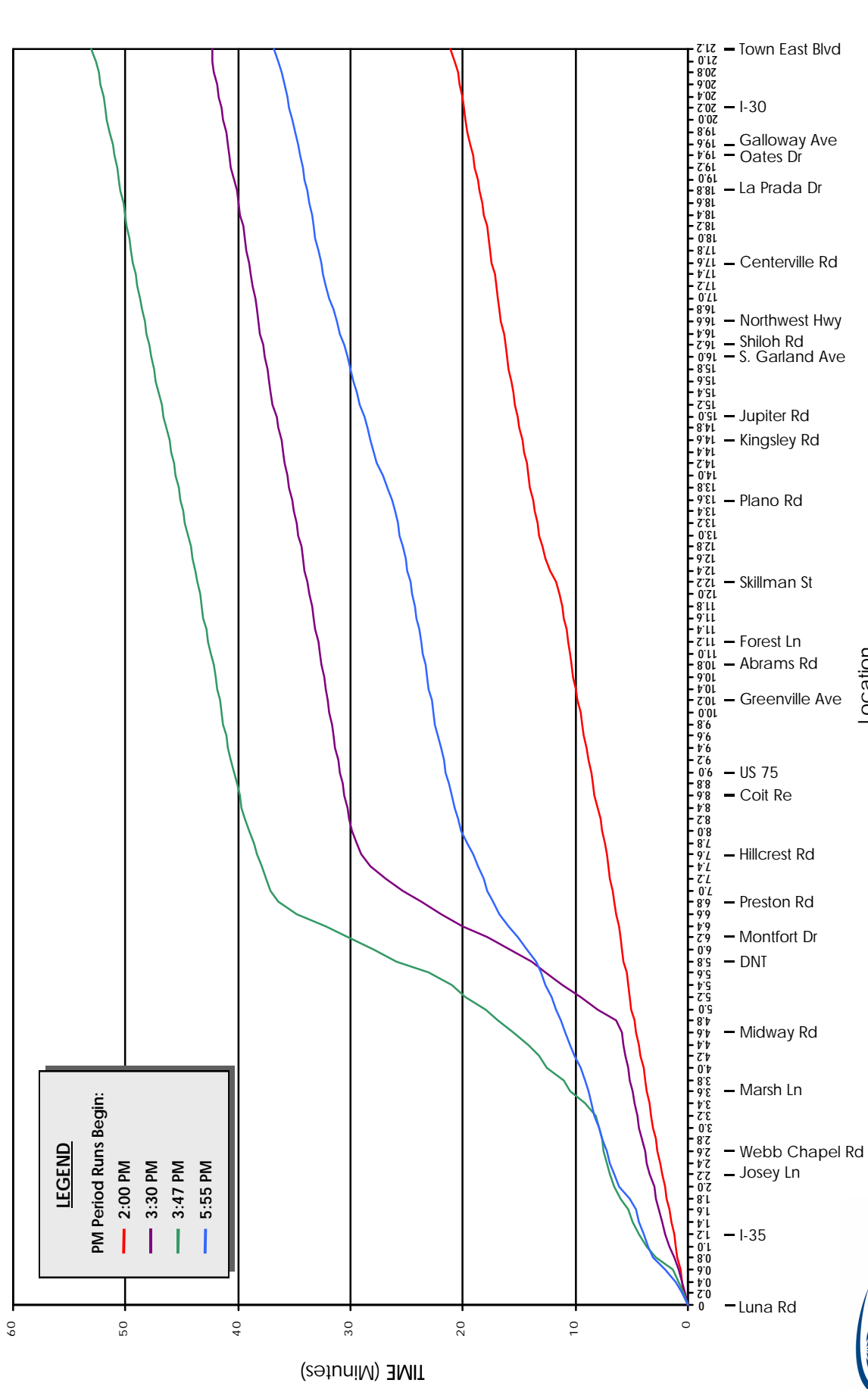
In the westbound direction during the A.M. time period, there is a substantial jump in travel times for both the 6:50 and the 7:50 a.m. runs, although the 7:50 a.m. run shows the highest increase in travel times in this section of the LBJ. With the exception of the run made at 9:43 a.m., all the runs show a strong increase in travel times after the Northwest Highway over the balance of the corridor, with a second marked increase in the vicinity of Midway.

In the eastbound direction the runs shown began over a period running from 2:00 through 5:55 p.m. The 2:00 p.m. run shows a steady rate of



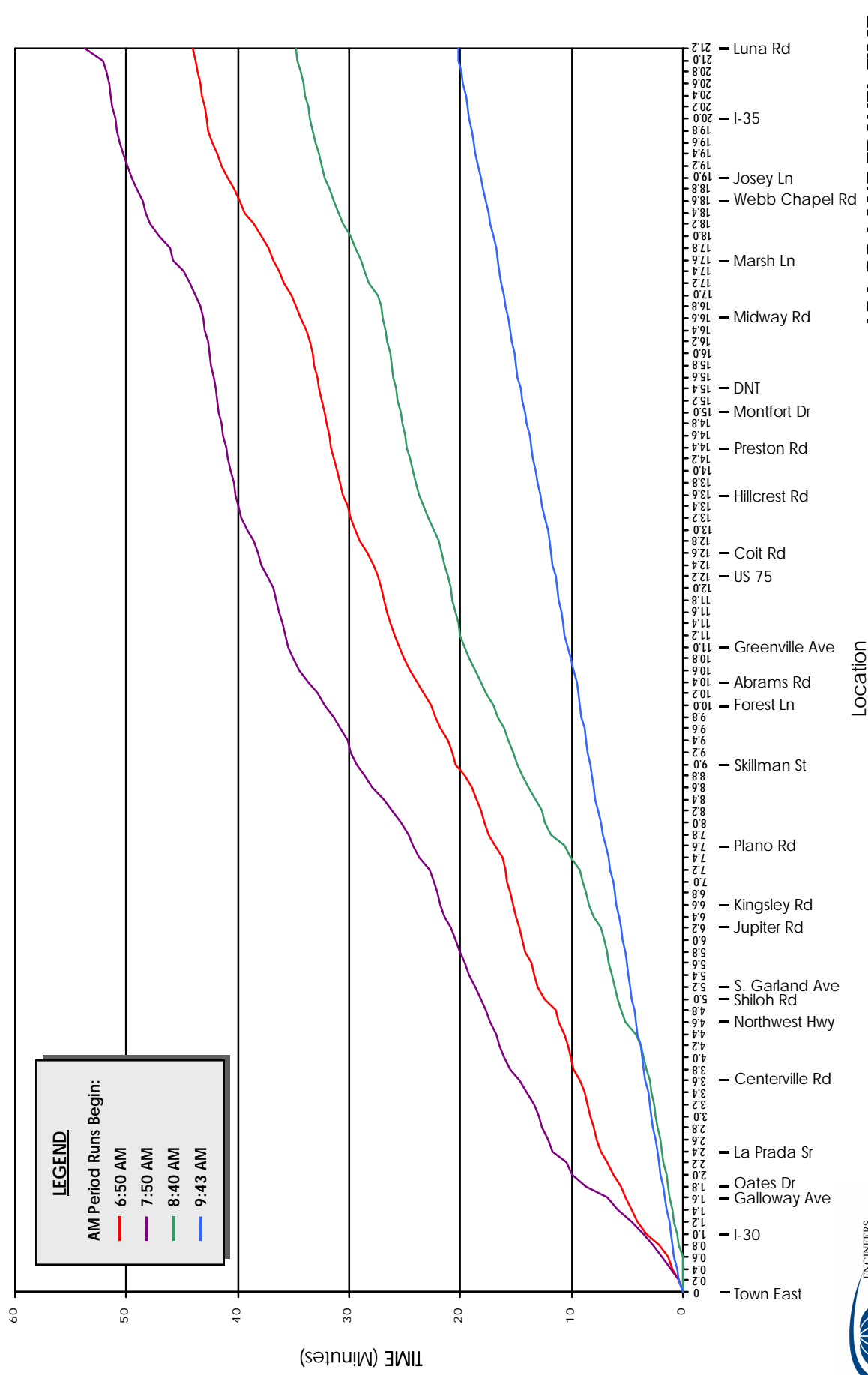
LBJ GP LANE TRAVEL TIME
AM EASTBOUND

FIGURE 2-8



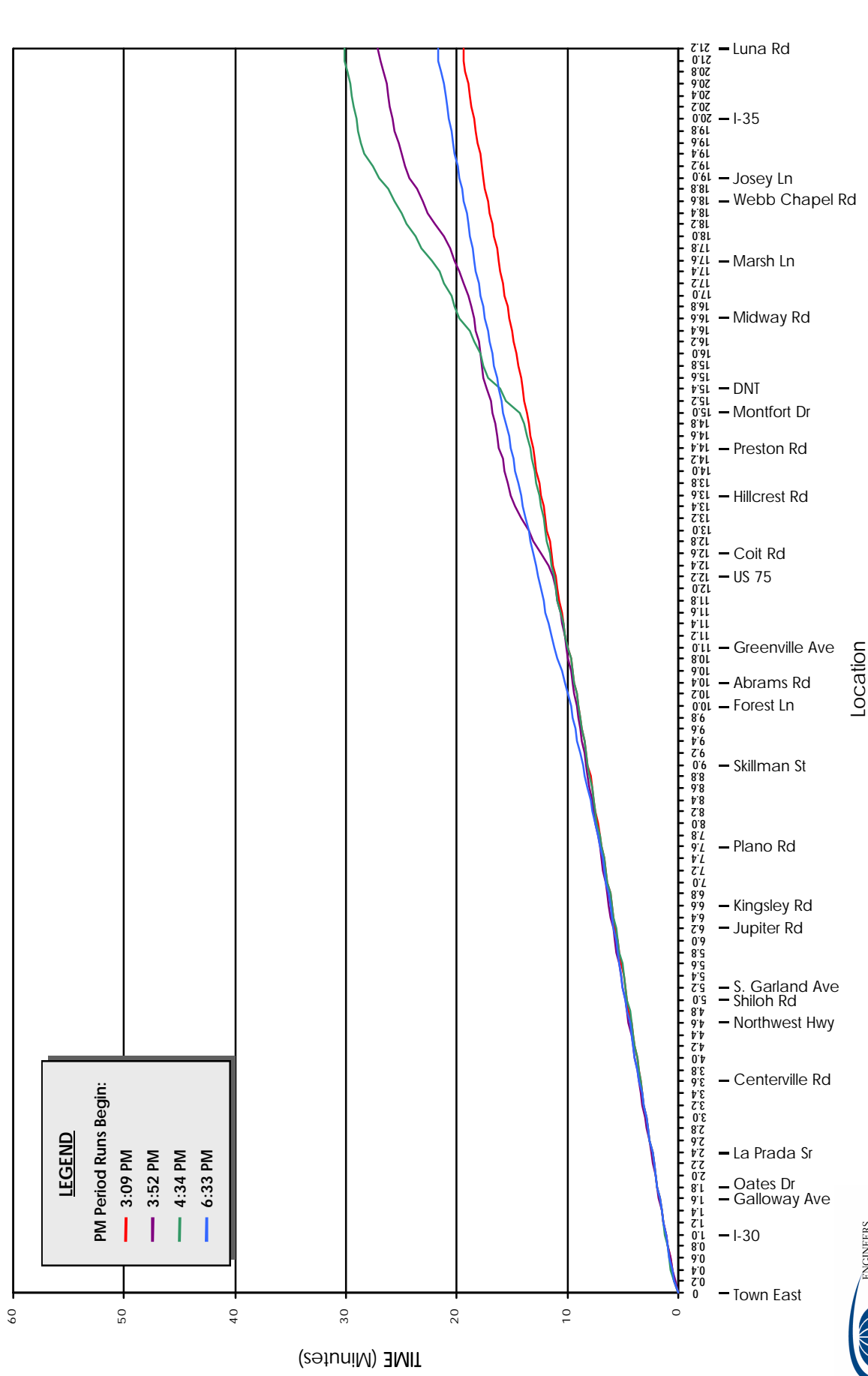
**LBJ GP LANE TRAVEL TIME
PM EASTBOUND**

FIGURE 2-9



**LBJ GP LANE TRAVEL TIME
AM WESTBOUND**

FIGURE 2-10



**LBJ GP LANE TRAVEL TIME
PM WESTBOUND**

FIGURE 2-11

travel time increase over the entire length, indicating that the P.M. “rush hour” traffic has yet to begin. The three later runs shown show a jump in travel time in the vicinity of the DNT and then show a steady rise in travel times thereafter.

In the westbound direction during the P.M. period, a selection of the travel runs that were made are shown in Figure 2-11. The runs made began at times running from 3:09 through 6:33 p.m. The run initiated at 3:09 p.m. shows a relatively steady increase in travel time over the entire length of the study segment. The run started at 6:33 p.m. shows a small increase in travel time in the vicinity of Abrams Road, but otherwise shows a relatively steady rate increase.

The two remaining intermediate runs made at 3:52 and 4:34 p.m. show the effects of rush hour travel by indicating sharp increases in travel time at U.S. 75 and Marsh Lane for the 3:52 p.m. run and at the DNT and Marsh Lane for the 4:34 p.m. run.

ALTERNATE ROUTE TRAVEL TIMES

Speed and delay runs were conducted on six parallel arterials to compare travel time saving on LBJ. Table 2-3 summarizes the time saving on LBJ in comparison to the arterials in four segments, between IH-35 and Midway Road, Midway and Preston Roads, Preston Road and U.S. 75, and U.S. 75 and Audelia Road. Overall, traveling on the LBJ has a positive time saving as compared to the parallel arterials, except during the eastbound P.M. peak period between Midway and Preston Roads. Average travel time saved by traveling on the LBJ during the eastbound A.M. period and westbound P.M. period is about 50 percent. The average time saved during A.M. westbound is approximately 32 percent and during P.M. eastbound approximately 26 percent.

VEHICLE OCCUPANCY

A vehicle occupancy survey was carried out on the LBJ at Welch Road, Greenville Avenue and Northwest Highway on March 31, April 1, and April 2, 1998, respectively, during the a.m. (7:00-9:00 a.m.), Midday (9:00 a.m.-4:00 p.m.), and p.m. (4:00-7:00 p.m.) periods. Each survey location was selected to represent a portion of the cross section of the travel characteristics represented in the LBJ corridor. This approach was used to better enable the study team to forecast future vehicle occupancy patterns.

Table 2-3
Travel Time Comparison LBJ vs. Alternate Route

| Section | Facility | AM Peak | | | | | | PM Peak | | | | | |
|---------------------------|-----------------------|--------------------------------|--------------------------|-------------|--------------------------------|--------------------------|-------------|--------------------------------|--------------------------|-------------|--------------------------------|--------------------------|-------------|
| | | Eastbound | | | Westbound | | | Eastbound | | | Westbound | | |
| | | Arterials Travel Time (min) | LBJ Travel Time (min) | Time Saving | Arterials Travel Time (min) | LBJ Travel Time (min) | Time Saving | Arterials Travel Time (min) | LBJ Travel Time (min) | Time Saving | Arterials Travel Time (min) | LBJ Travel Time (min) | Time Saving |
| I-35E to Midway | 1) Spring Valley Road | 11.87 | 5.42 | 6.45 | 10.38 | 5.93 | 4.45 | 11.08 | 6.54 | 4.54 | 12.31 | 6.07 | 6.24 |
| | 2) Valley View Lane | 8.83 | 5.42 | 3.41 | 8.78 | 5.93 | 2.85 | 9.47 | 6.54 | 2.93 | 9.55 | 6.07 | 3.48 |
| | 3) LBJ Frontage Road | | | | | | | | | | | | |
| | 4) Forest Lane | | | | | | | | | | | | |
| | 5) North Haven Road | | | | | | | | | | | | |
| | 6) Royal Lane | 7.74 | 5.42 | 2.32 | 8.09 | 5.93 | 2.16 | 8.06 | 6.54 | 1.52 | 10.20 | 6.07 | 4.13 |
| Midway to Preston | 1) Spring Valley Road | 5.45 | 2.27 | 3.18 | 6.19 | 2.37 | 3.82 | 6.29 | 6.41 | -0.12 | 6.44 | 2.91 | 3.53 |
| | 2) Valley View Lane | 5.92 | 2.27 | 3.65 | 5.77 | 2.37 | 3.40 | 6.97 | 6.41 | 0.56 | 6.37 | 2.91 | 3.46 |
| | 3) LBJ Frontage Road | 6.44 | 2.27 | 4.17 | 6.50 | 2.37 | 4.13 | 6.27 | 6.41 | -0.14 | 9.05 | 2.91 | 6.14 |
| | 4) Forest Lane | 3.89 | 2.27 | 1.62 | 3.66 | 2.37 | 1.29 | 5.34 | 6.41 | -1.07 | 3.95 | 2.91 | 1.04 |
| | 5) North Haven Road | 5.40 | 2.27 | 3.13 | 5.16 | 2.37 | 2.79 | 5.78 | 6.41 | -0.63 | 5.34 | 2.91 | 2.43 |
| | 6) Royal Lane | 4.35 | 2.27 | 2.08 | 3.99 | 2.37 | 1.62 | 6.35 | 6.41 | -0.06 | 3.75 | 2.91 | 0.84 |
| Preston to U.S. 75 | 1) Spring Valley Road | 8.50 | 2.50 | 6.00 | 7.89 | 3.57 | 4.32 | 10.06 | 3.92 | 6.14 | 9.90 | 2.69 | 7.21 |
| | 2) Valley View Lane | | | | | | | | | | | | |
| | 3) LBJ Frontage Road | | | | | | | | | | | | |
| | 4) Forest Lane | 4.02 | 2.50 | 1.52 | 3.94 | 3.57 | 0.37 | 4.67 | 3.92 | 0.75 | 3.77 | 2.69 | 1.08 |
| | 5) North Haven Road | | | | | | | | | | | | |
| | 6) Royal Lane | 4.70 | 2.50 | 2.20 | 4.17 | 3.57 | 0.60 | 4.91 | 3.92 | 0.99 | 4.54 | 2.69 | 1.85 |
| U.S. 75 to Audelia | 1) Spring Valley Road | | | | | | | | | | | | |
| | 2) Valley View Lane | | | | | | | | | | | | |
| | 3) LBJ Frontage Road | | | | | | | | | | | | |
| | 4) Forest Lane | 6.72 | 3.13 | 3.59 | 8.65 | 6.49 | 2.16 | 9.68 | 4.13 | 5.55 | 8.53 | 3.13 | 5.40 |
| | 5) North Haven Road | | | | | | | | | | | | |
| | 6) Royal Lane | 6.27 | 3.13 | 3.14 | 7.15 | 6.49 | 0.66 | 6.61 | 4.13 | 2.48 | 8.58 | 3.13 | 5.45 |

* Negative time indicates LBJ delay relative to travel in arterials.

The Welch Road survey location is to the immediate west of the DNT and at the middle of the existing HOV lane between IH-35E and U.S. 75. It represents vehicle occupancy characteristics of high traffic volumes and with HOV lane alternatives. Greenville Avenue is located at the middle of the LBJ study segment, east of U.S. 75. It carries a substantial amount of traffic from and to U.S. 75. It simulates similar conditions as the Welch Road survey location but without HOV lane availability. Northwest Highway is located near the end part of the LBJ study segment. It constitutes part of the proposed future reversible MLs.

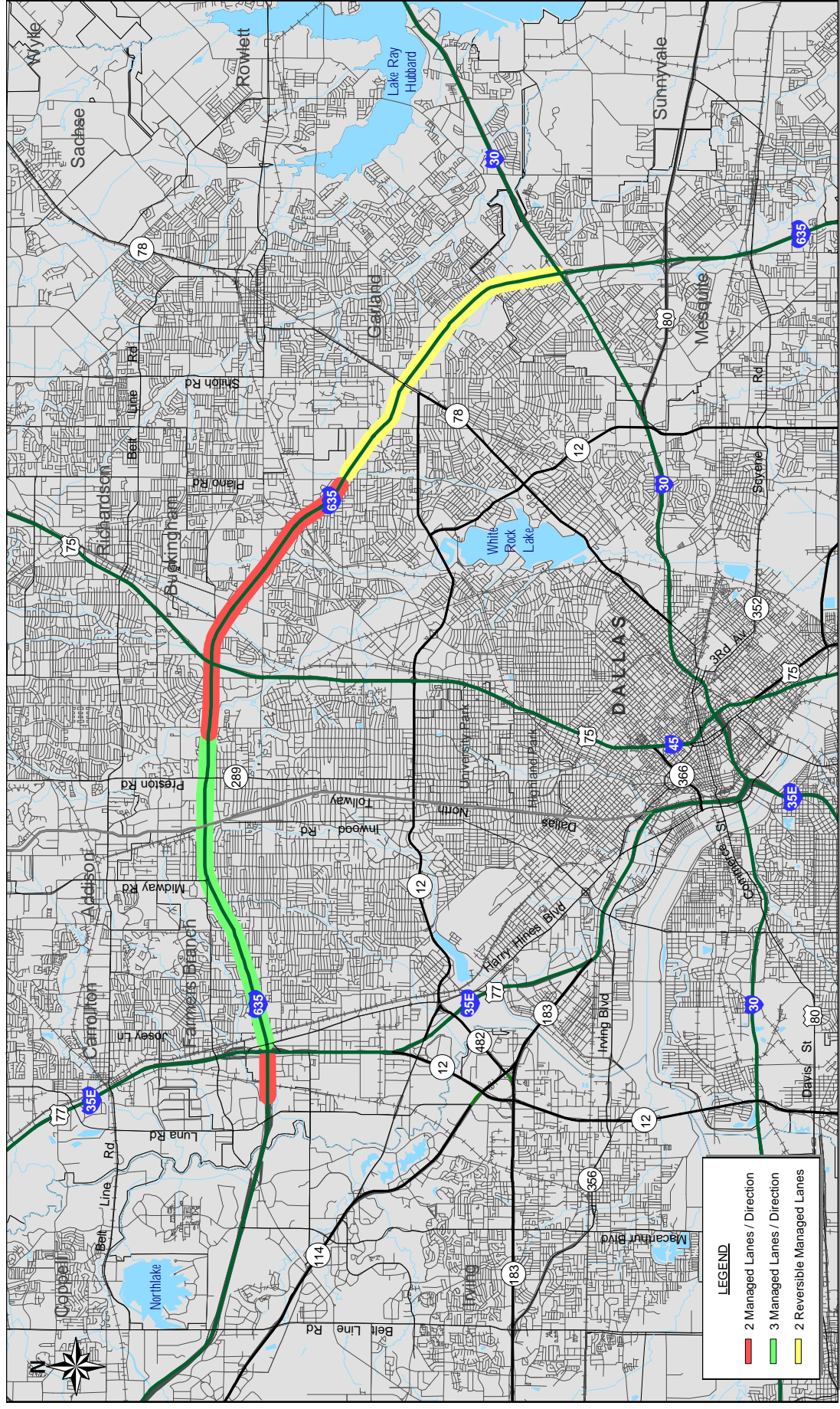
A summary of the vehicle occupancy survey is presented in Figure 2-12, Vehicle Occupancy Profile at Selected Locations, and Figure 2-13, HOV Use on the LBJ HOV and GP lanes. At all survey locations, HOV3+ constitutes less than 2 percent of the vehicles on the road, while more than 85 percent of the vehicles were SOVs. The percentage of HOVs at Welch Road is generally higher than on Greenville Avenue and Northwest Highway. The average percentage of HOVs on the road where no HOV lane was present is approximately 14 percent.

The HOV distribution between HOV lanes and GP lanes at Welch Road shows that only about half of the HOVs use the HOV lane. In the Midday travel period, the number of HOV lane users is lower than A.M. and P.M. travel periods in the GP lanes on Welch Road. The data suggests that when the GP lanes are not relatively congested enough, HOVs will not be attracted to use HOV lanes.

SUMMARY

Based on the extensive traffic survey of the LBJ Freeway users of the ML study segment and its vicinity, the major observations on the existing traffic conditions are:

- ✍ From both the traffic counts and speed and delay runs, westbound A.M. peak period and eastbound P.M. peak period are more congested than the reverse directions, in each peak;
- ✍ The LBJ Freeway section between I-35 to U.S. 75 in both directions at all periods, on average, has the highest traffic volumes and lowest travel speed;
- ✍ Using the LBJ Freeway generally provides travel time savings over competing arterials, except during the eastbound P.M. peak period between Midway and Preston Roads;

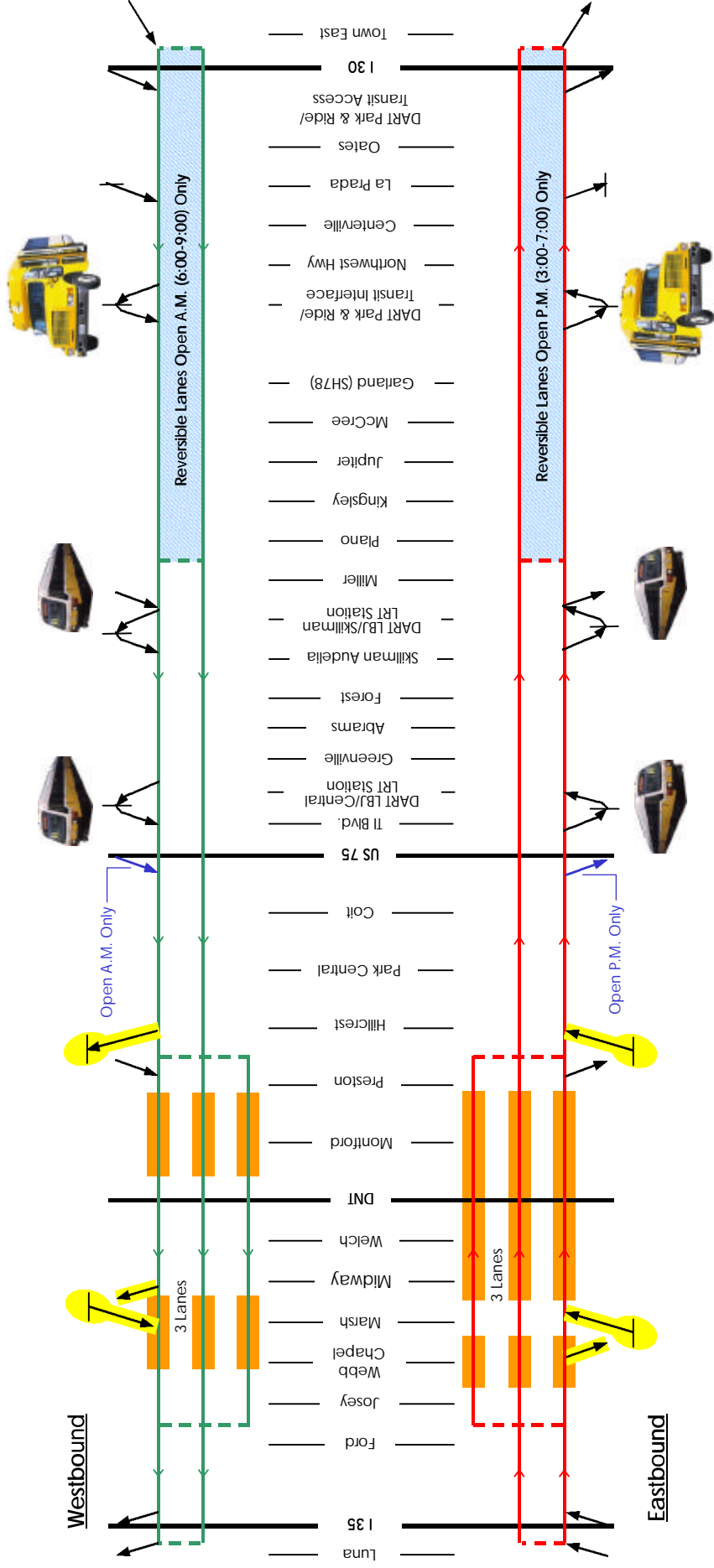


PROJECT LOCATION MAP

FIGURE 1-1

LBJ Freeway Managed Lanes Study

357060 / 6-1-01 / Schematic 8.5x11 .ppt



Frontage Road Connection

General Purpose/Managed Lane Connection

Intersection Street Connection

Ramps Do Not Exist in Reduced Access Configuration

Below Grade

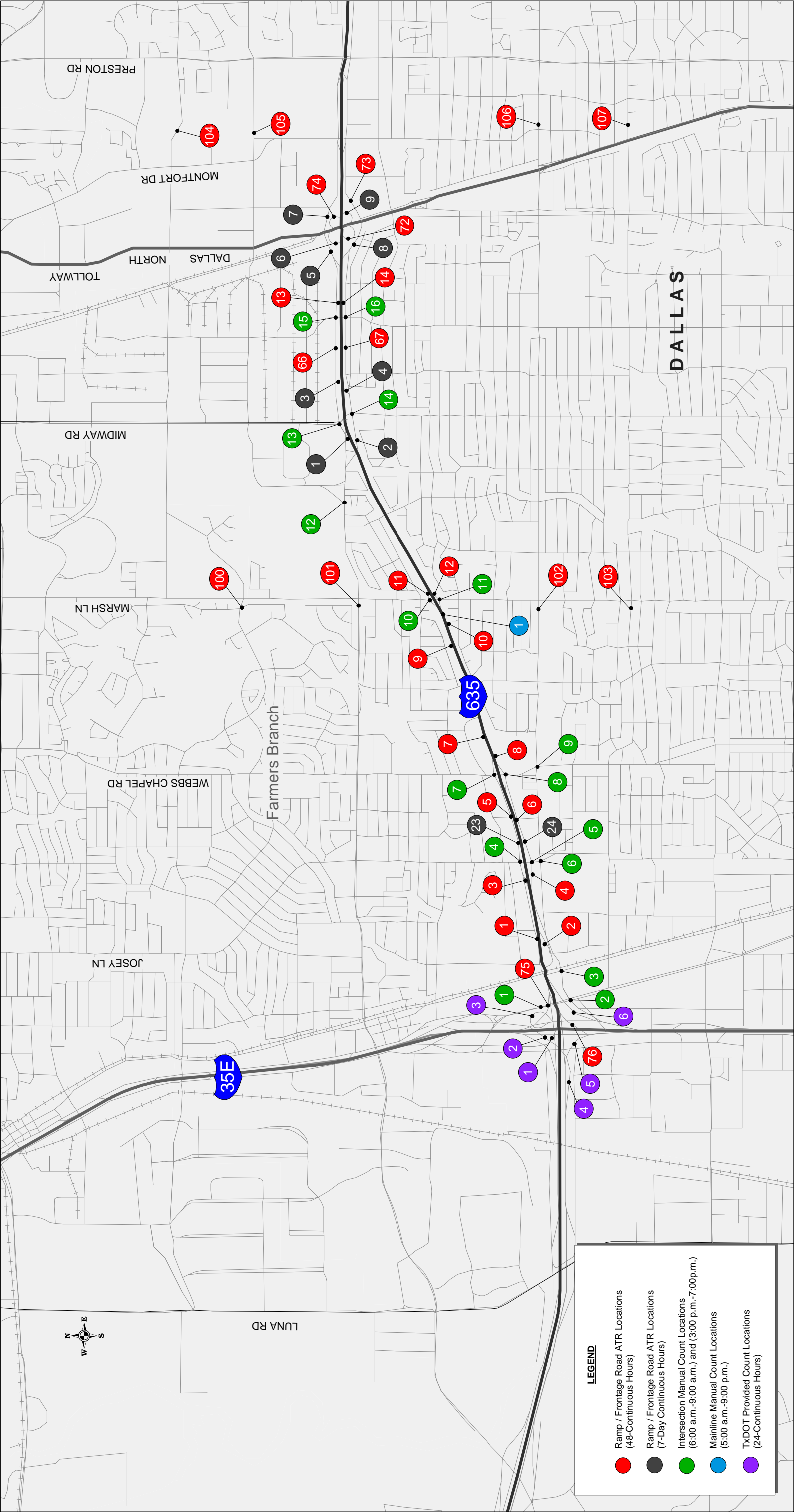
Rail

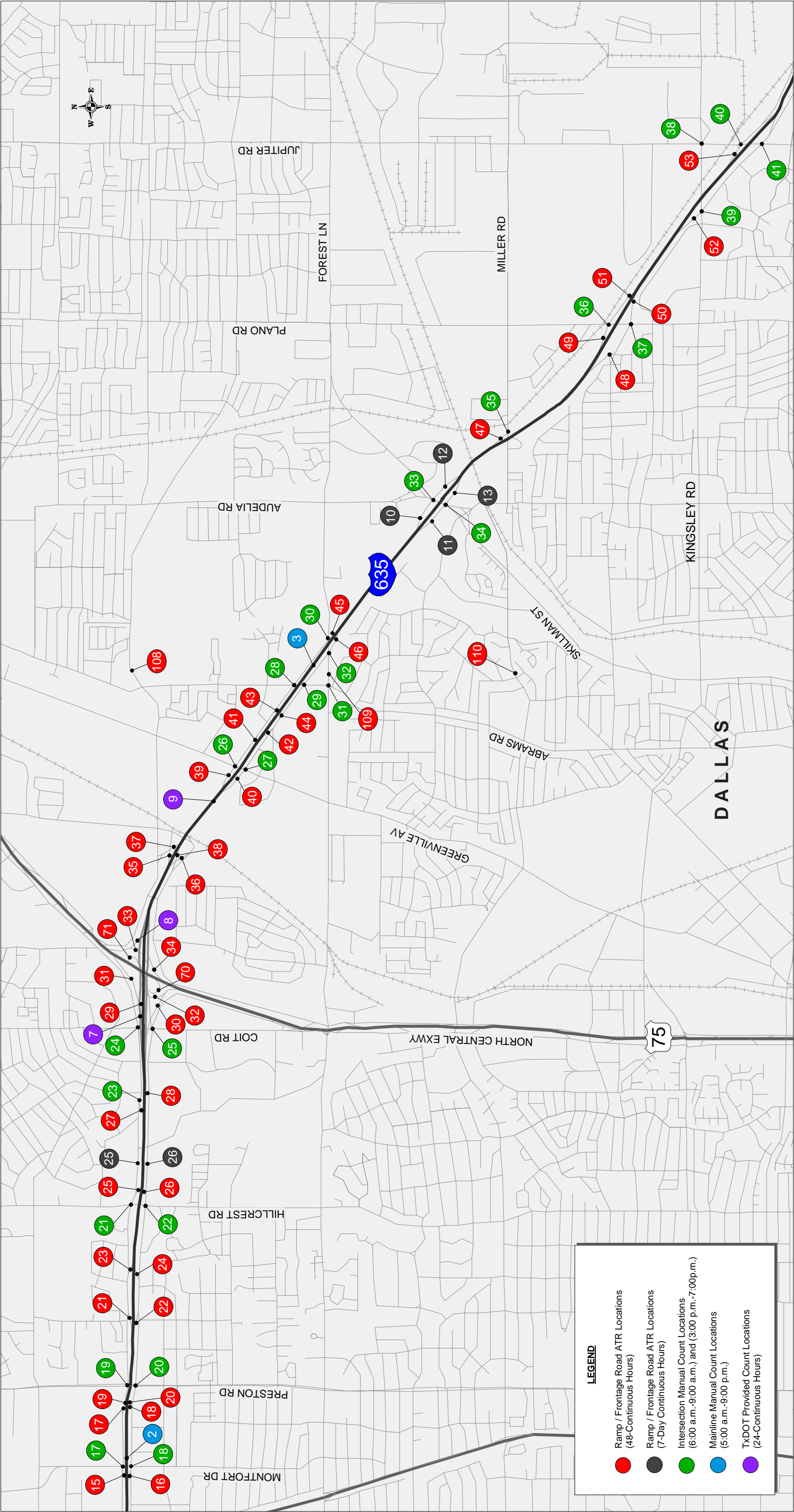
Bus

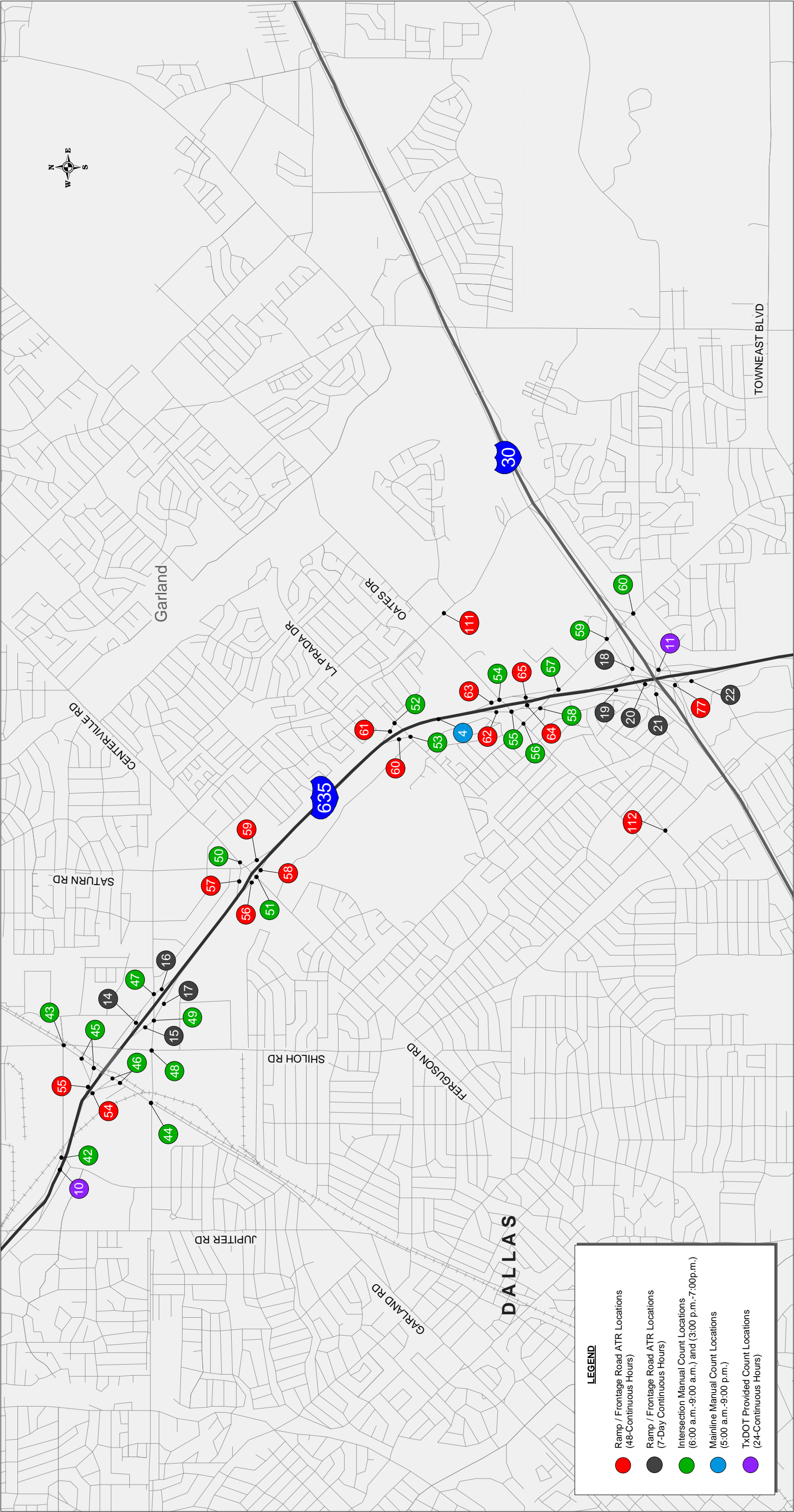
Intermodal Transfer Points

MANAGED LANES - ACCESS LOCATIONS

FIGURE 1-2

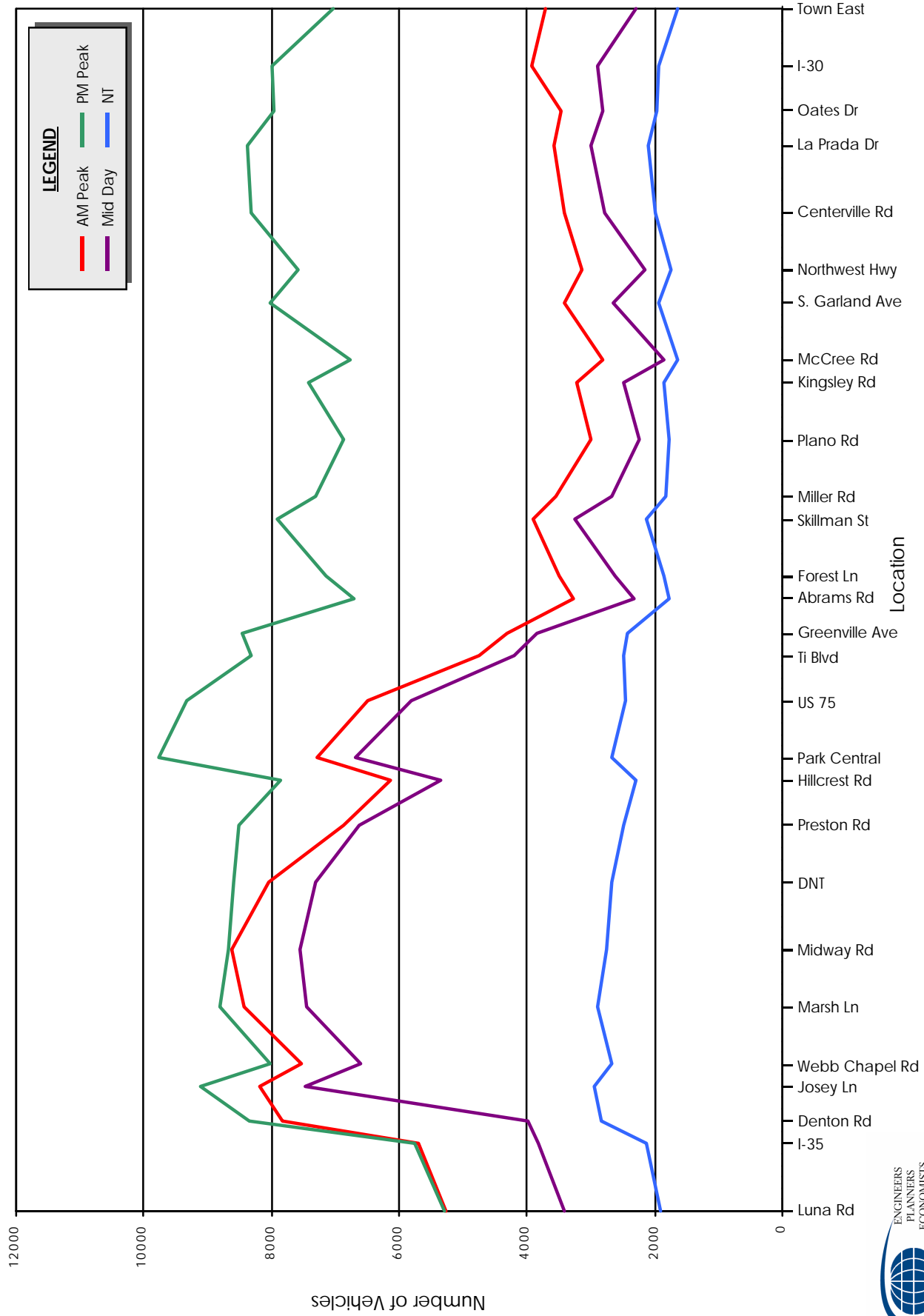






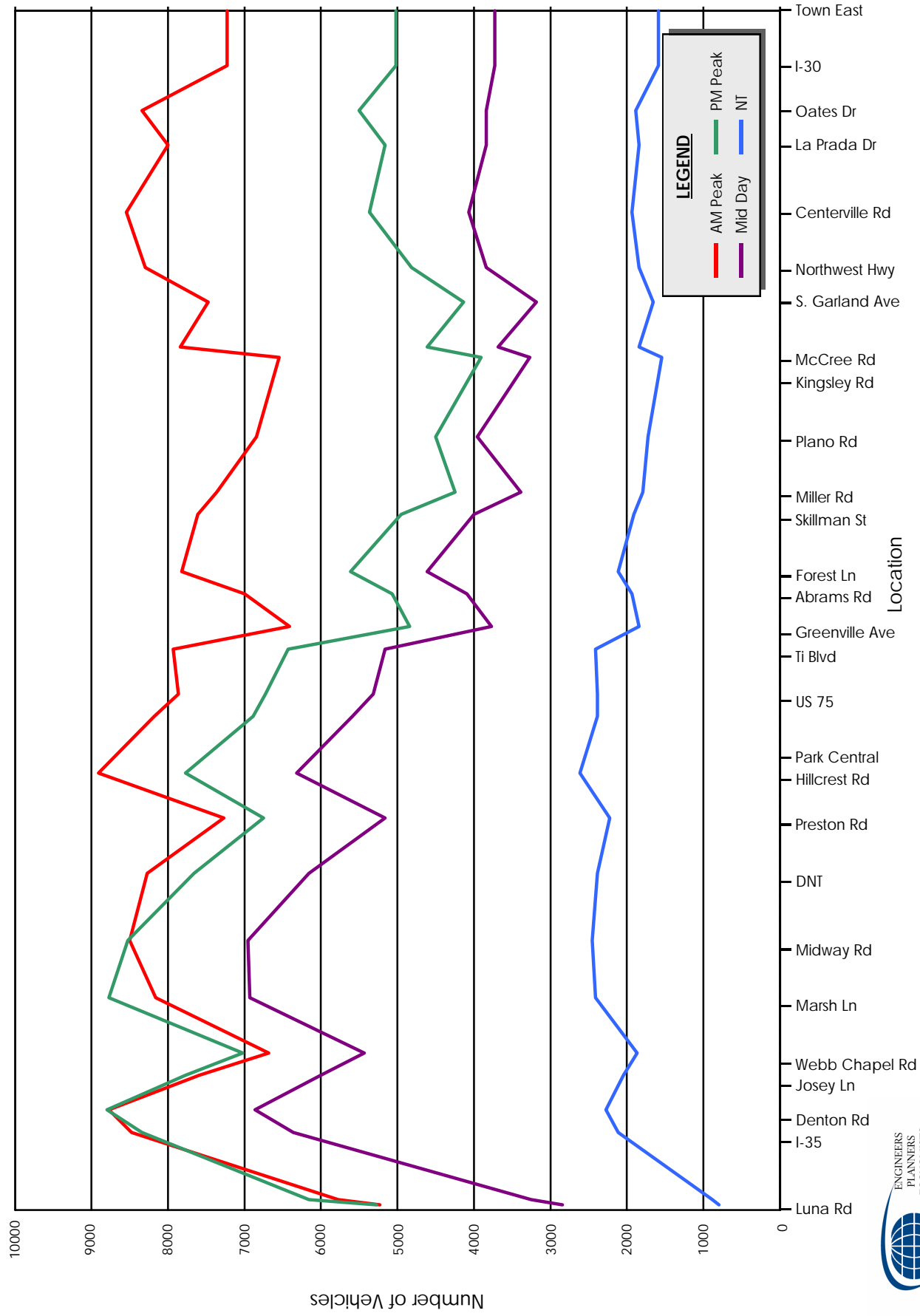
TRAFFIC COUNT LOCATIONS

FIGURE 2-1



LBJ GP LANES, EASTBOUND WEEKDAY AVERAGE HOURLY TRAFFIC BY PERIOD

FIGURE 2-2



LBJ GP LANES, WESTBOUND WEEKDAY AVERAGE HOURLY TRAFFIC BY PERIOD

FIGURE 2-3

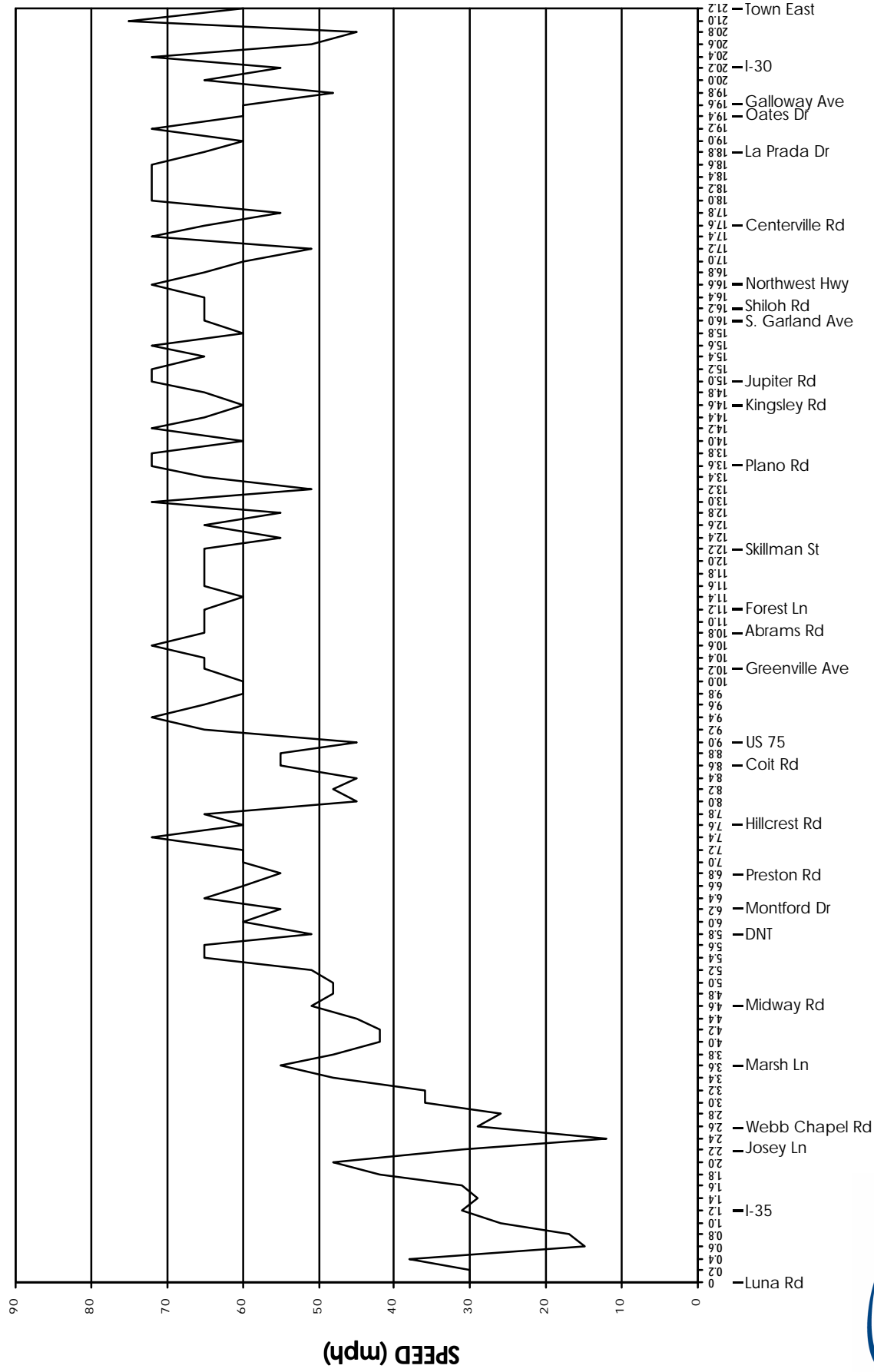
Table 2-1
Daily Traffic Variations
Selected LBJ Frontage Ramps*

| Day | Ramps 1 & 2 West of Midway Road | Ramps 5 & 6 West of DNT | Ramps 12 & 13 East of Skillman/Audelia Road | Ramps 16 & 17 East of NW Highway |
|---|--|--|--|---|
| Monday | 31,297 | 22,079 | 15,706 | 35,166 |
| Tuesday | 30,528 | 22,407 | 15,628 | 36,002 |
| Wednesday | 30,748 | 24,091 | 15,297 | 36,371 |
| Thursday | 32,358 | 24,713 | 16,424 | 37,421 |
| Friday | 31,305 | 26,622 | 15,980 | 38,858 |
| Saturday | 23,593 | 19,324 | 17,441 | 33,419 |
| Sunday | <u>16,206</u> | <u>14,389</u> | <u>12,874</u> | <u>25,955</u> |
| TOTAL | 196,035 | 153,625 | 109,350 | 243,192 |
| Average Daily | 28,005 | 21,946 | 15,621 | 34,742 |
| PERCENT OF AVERAGE DAILY (INDEX) | | | | |
| Monday | 111.8 | 100.6 | 100.5 | 101.2 |
| Tuesday | 109.0 | 102.1 | 100.0 | 103.6 |
| Wednesday | 109.8 | 109.8 | 97.9 | 104.7 |
| Thursday | 115.5 | 112.6 | 105.1 | 107.7 |
| Friday | 111.8 | 121.3 | 102.3 | 111.8 |
| Saturday | 84.2 | 88.1 | 111.6 | 96.2 |
| Sunday | 57.9 | 65.6 | 82.4 | 74.7 |
| Average Day | 100.0 | 100.0 | 100.0 | 100.0 |

* See Figure 2-1 for locations of ramps by number.

Table 2-2
Vehicle Class Distribution

| Location/Period | Time Period | | | | | | | | | | | |
|------------------------|-------------------|-------------------|-----------------|-------------------|-----------------|-------------------|--------|----------------------|-----------------|-----------------|-------|------|
| | Passenger Cars | Average Hourly | Light Trucks | Average Hourly | Heavy Trucks | Average Hourly | Total | Percent Distribution | | | Total | |
| | | | | | | | | Passenger Cars | Light Trucks | Heavy Trucks | | |
| 1. MARSH LN | | | | | | | | | | | | |
| AM Peak | 39,395 | 13,132 | 5,403 | 1,801 | 1,807 | 602 | 46,605 | 15,535 | 84.53% | 11.59% | 3.88% | 100% |
| Midday | 86,773 | 14,462 | 4,715 | 786 | 3,896 | 649 | 95,384 | 15,897 | 90.97% | 4.94% | 4.08% | 100% |
| PM Peak | 51,958 | 12,990 | 1,904 | 476 | 1,997 | 499 | 55,859 | 13,965 | 93.02% | 3.41% | 3.58% | 100% |
| Others | 30,049 | 2,732 | 1,242 | 113 | 1,212 | 110 | 32,503 | 2,955 | 92.45% | 3.82% | 3.73% | 100% |
| 2. MONTFORT DR | | | | | | | | | | | | |
| AM Peak | 44,606 | 14,869 | 1,239 | 413 | 1,183 | 394 | 47,028 | 15,676 | 94.85% | 2.63% | 2.52% | 100% |
| Midday | 90,495 | 15,083 | 3,483 | 581 | 4,012 | 669 | 97,990 | 16,332 | 92.35% | 3.55% | 4.09% | 100% |
| PM Peak | 60,154 | 15,039 | 993 | 248 | 1,594 | 399 | 62,741 | 15,685 | 95.88% | 1.58% | 2.54% | 100% |
| Others | 34,651 | 3,150 | 292 | 27 | 1,052 | 96 | 35,995 | 3,272 | 96.27% | 0.81% | 2.92% | 100% |
| 3. ABRAMS RD-FOREST LN | | | | | | | | | | | | |
| AM Peak | 27,663 | 9,221 | 703 | 234 | 1,143 | 381 | 29,509 | 9,836 | 93.74% | 2.38% | 3.87% | 100% |
| Midday | 52,489 | 8,748 | 2,732 | 455 | 3,570 | 595 | 58,791 | 9,799 | 89.28% | 4.65% | 6.07% | 100% |
| PM Peak | 45,256 | 11,314 | 1,319 | 330 | 1,419 | 355 | 47,994 | 11,999 | 94.30% | 2.75% | 2.96% | 100% |
| Others | 19,722 | 1,793 | 479 | 44 | 973 | 88 | 21,174 | 1,925 | 93.14% | 2.26% | 4.60% | 100% |
| 4. LA PRADA LN | | | | | | | | | | | | |
| AM Peak | 24,136 | 8,045 | 846 | 282 | 1,225 | 408 | 26,207 | 8,736 | 92.10% | 3.23% | 4.67% | 100% |
| Midday | 51,864 | 8,644 | 2,592 | 432 | 3,678 | 613 | 58,134 | 9,689 | 89.21% | 4.46% | 6.33% | 100% |
| PM Peak | 50,046 | 12,512 | 1,510 | 378 | 1,838 | 460 | 53,394 | 13,349 | 93.73% | 2.83% | 3.44% | 100% |
| Others | 21,477 | 1,952 | 486 | 44 | 1,045 | 95 | 23,008 | 2,092 | 93.35% | 2.11% | 4.54% | 100% |



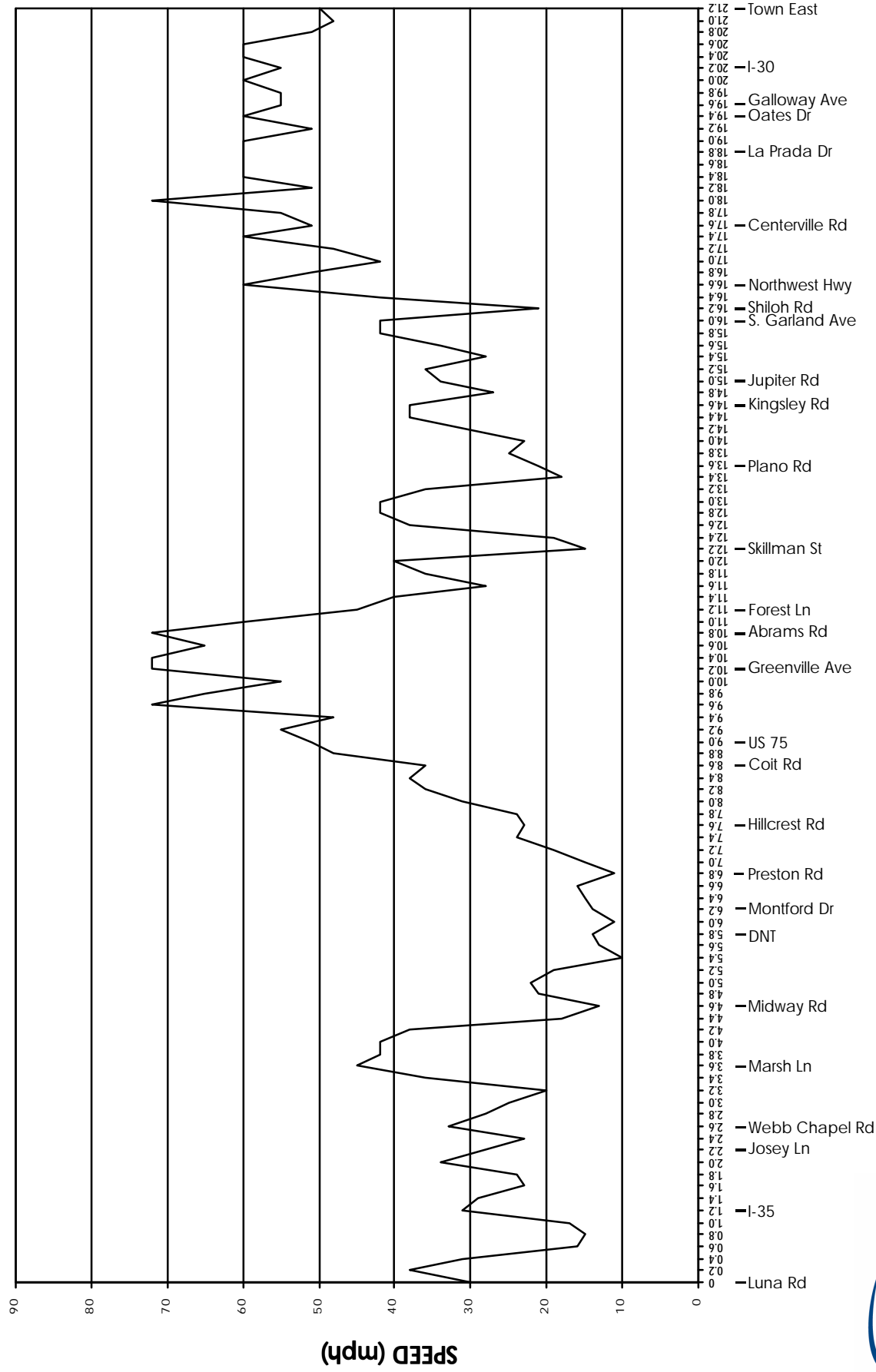
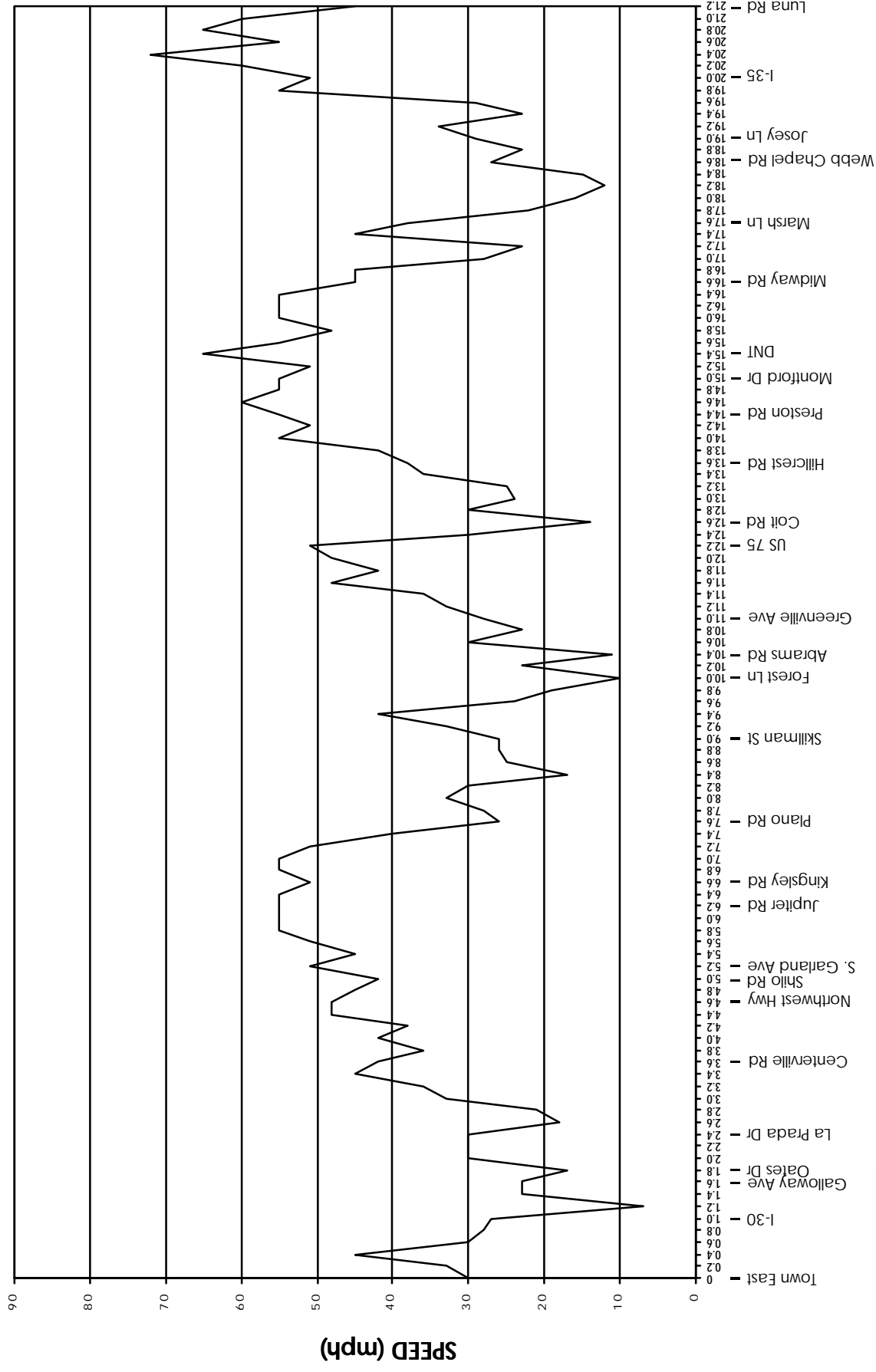
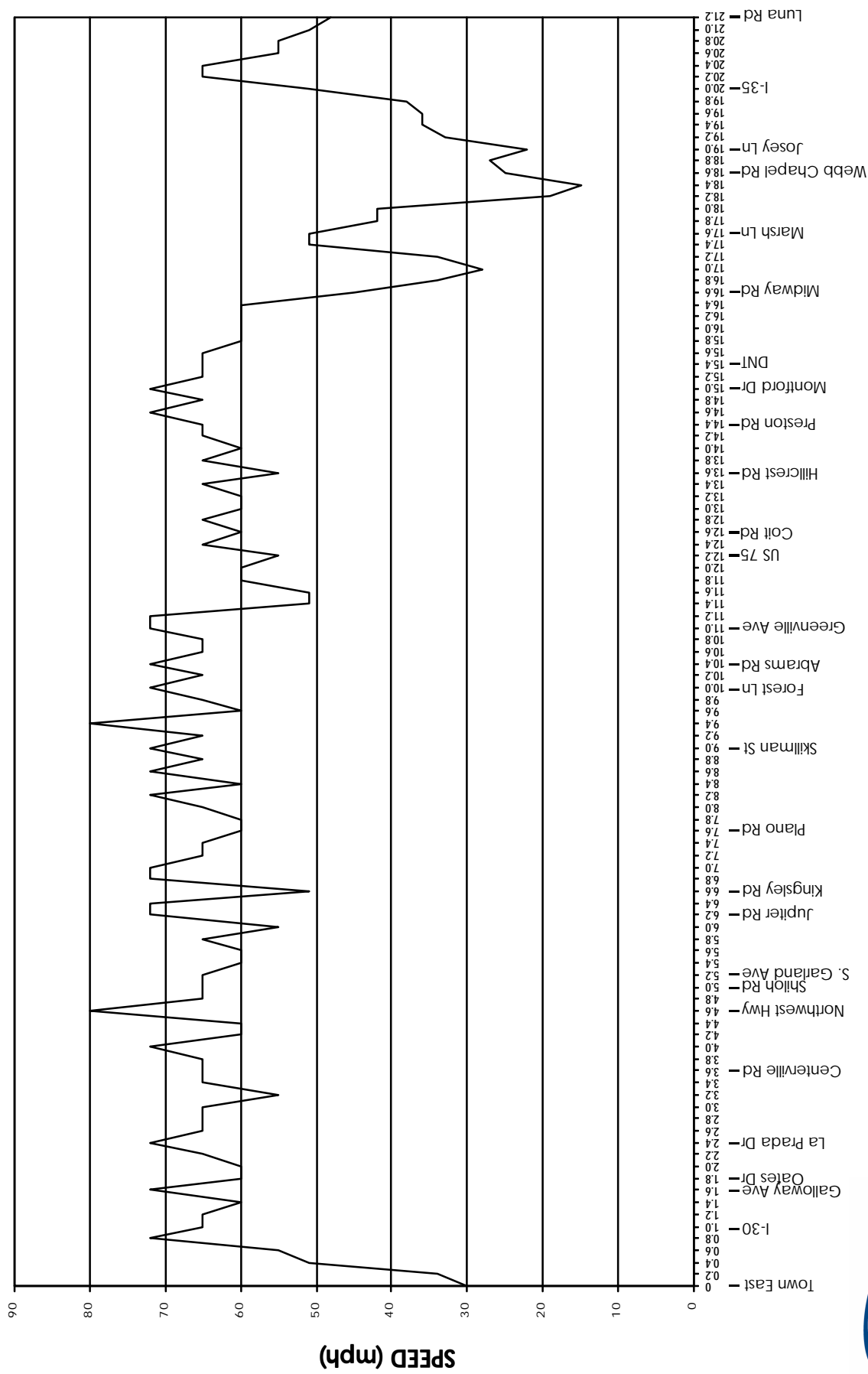


FIGURE 2-5

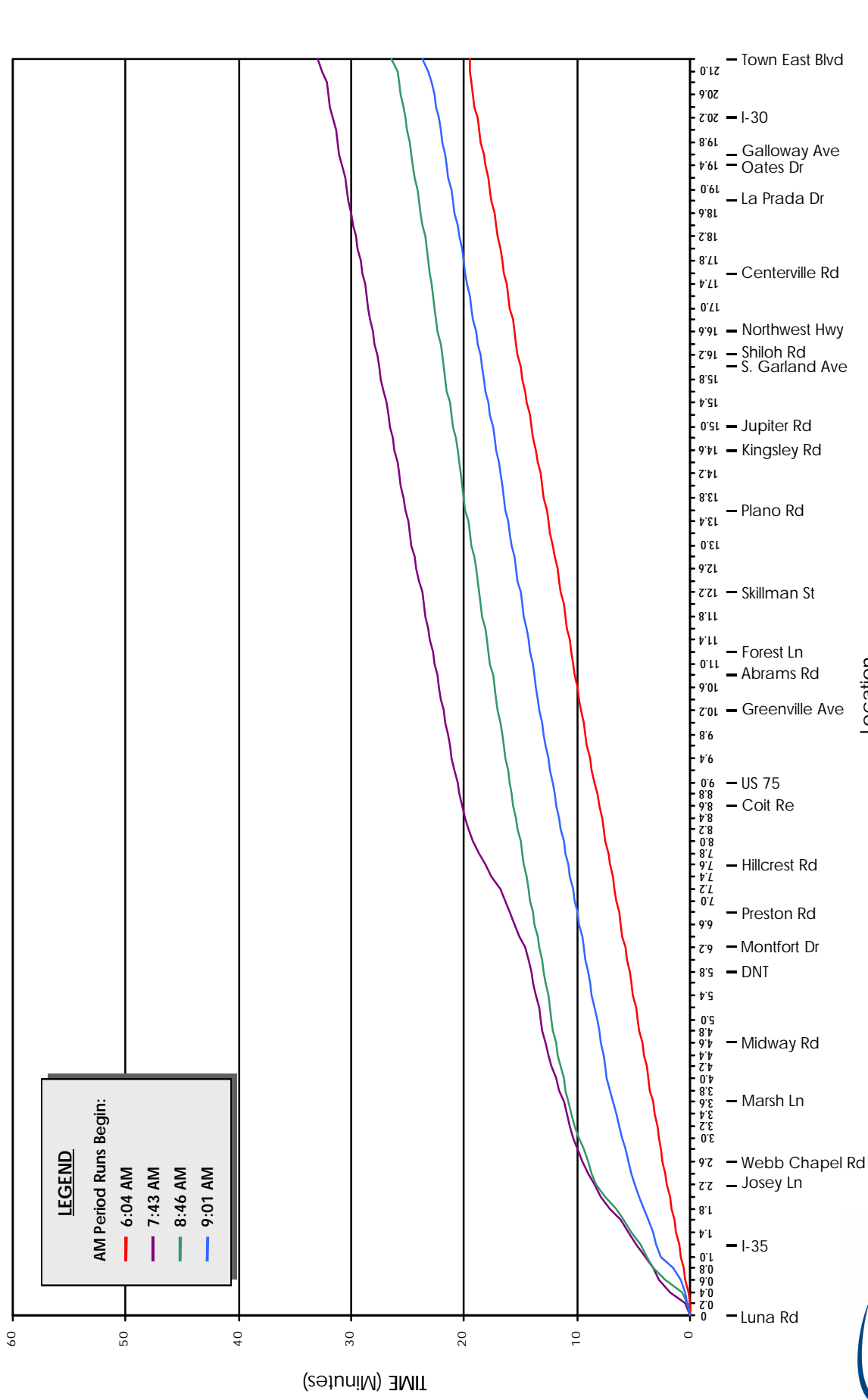


OBSERVED LBJ GP LANE TRAVEL SPEEDS
WESTBOUND AM PEAK PERIOD



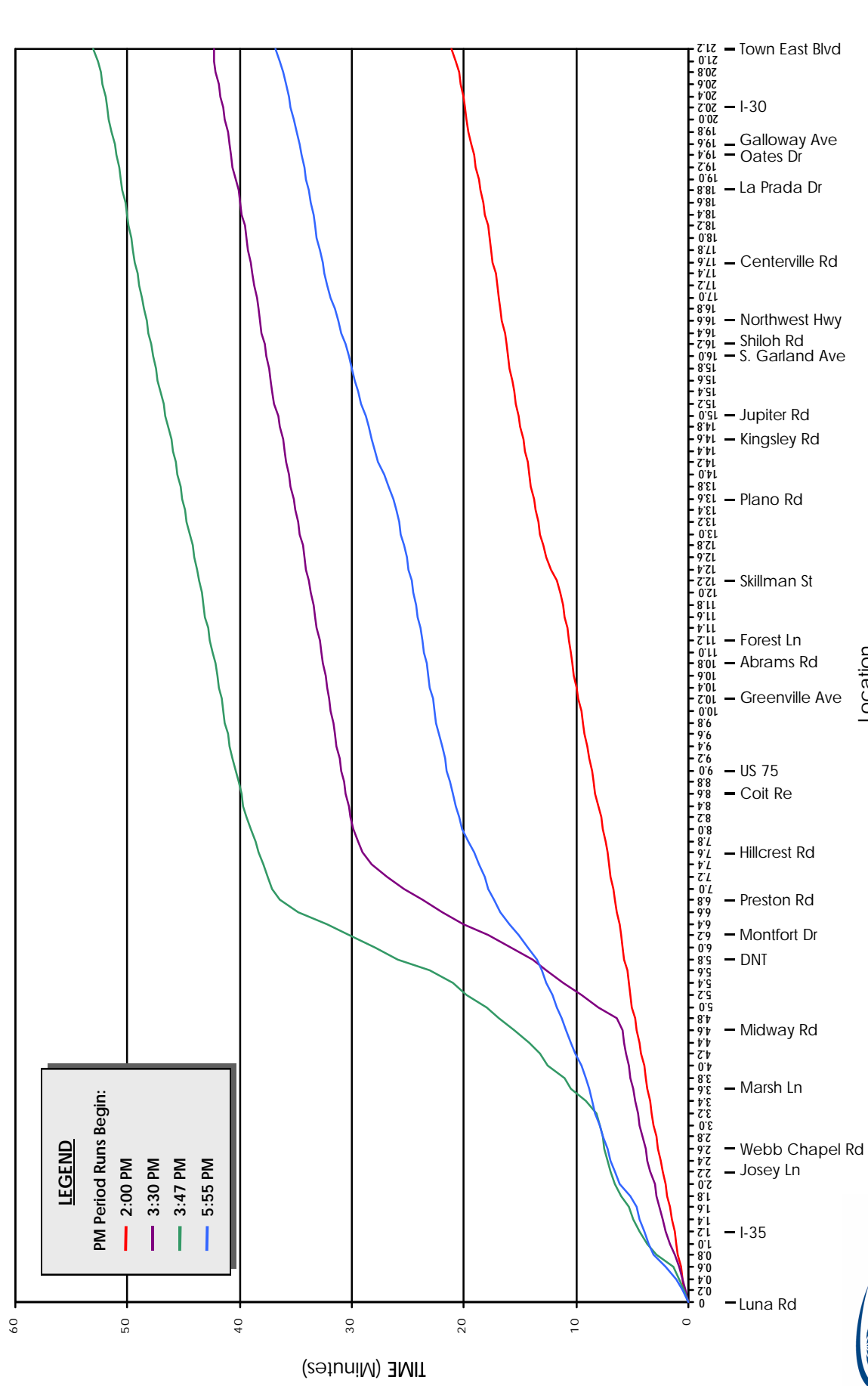
OBSERVED LBJ GP LANE TRAVEL SPEEDS
WESTBOUND PM PEAK PERIOD

FIGURE 2-7



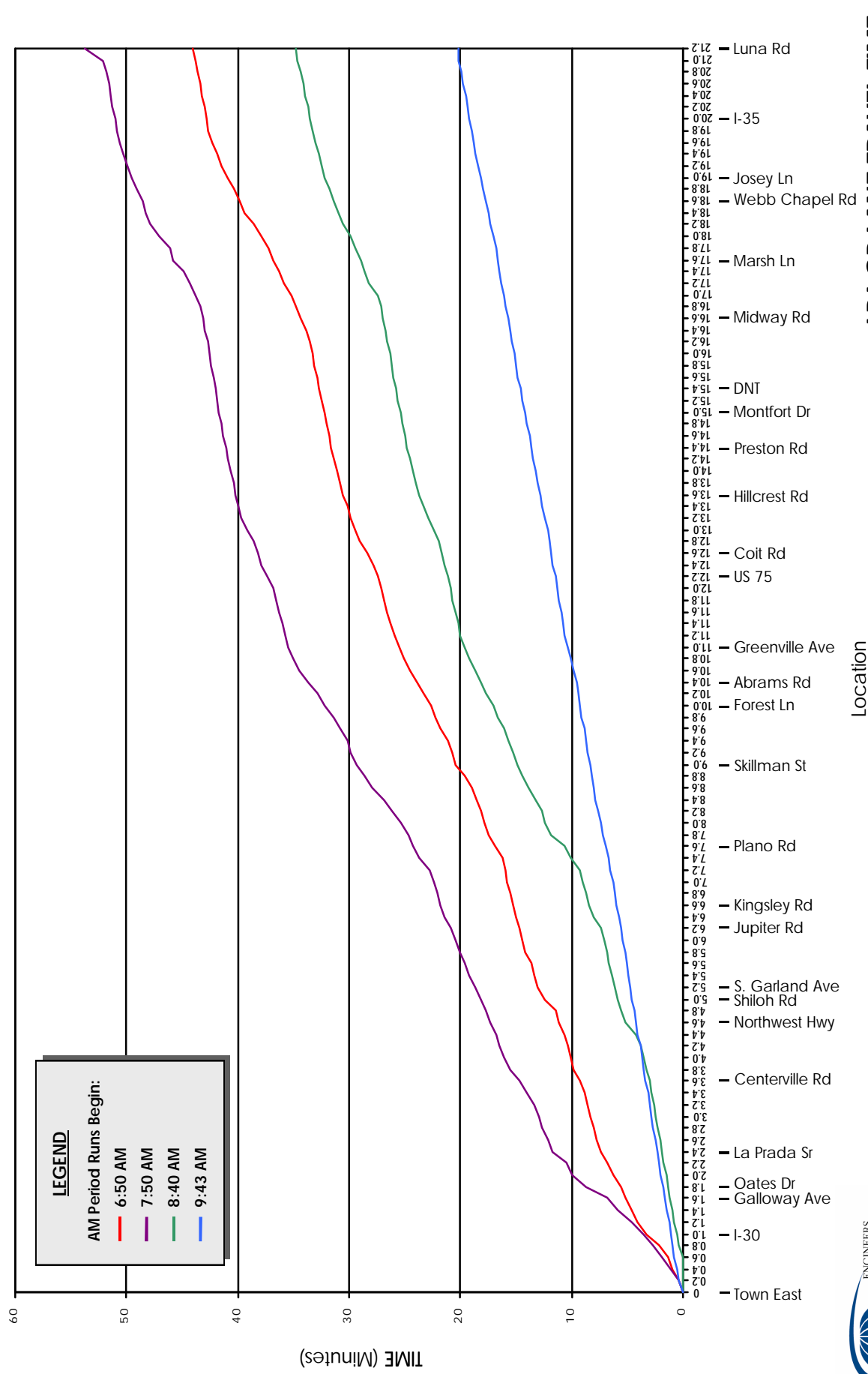
LBJ GP LANE TRAVEL TIME
AM EASTBOUND

FIGURE 2-8



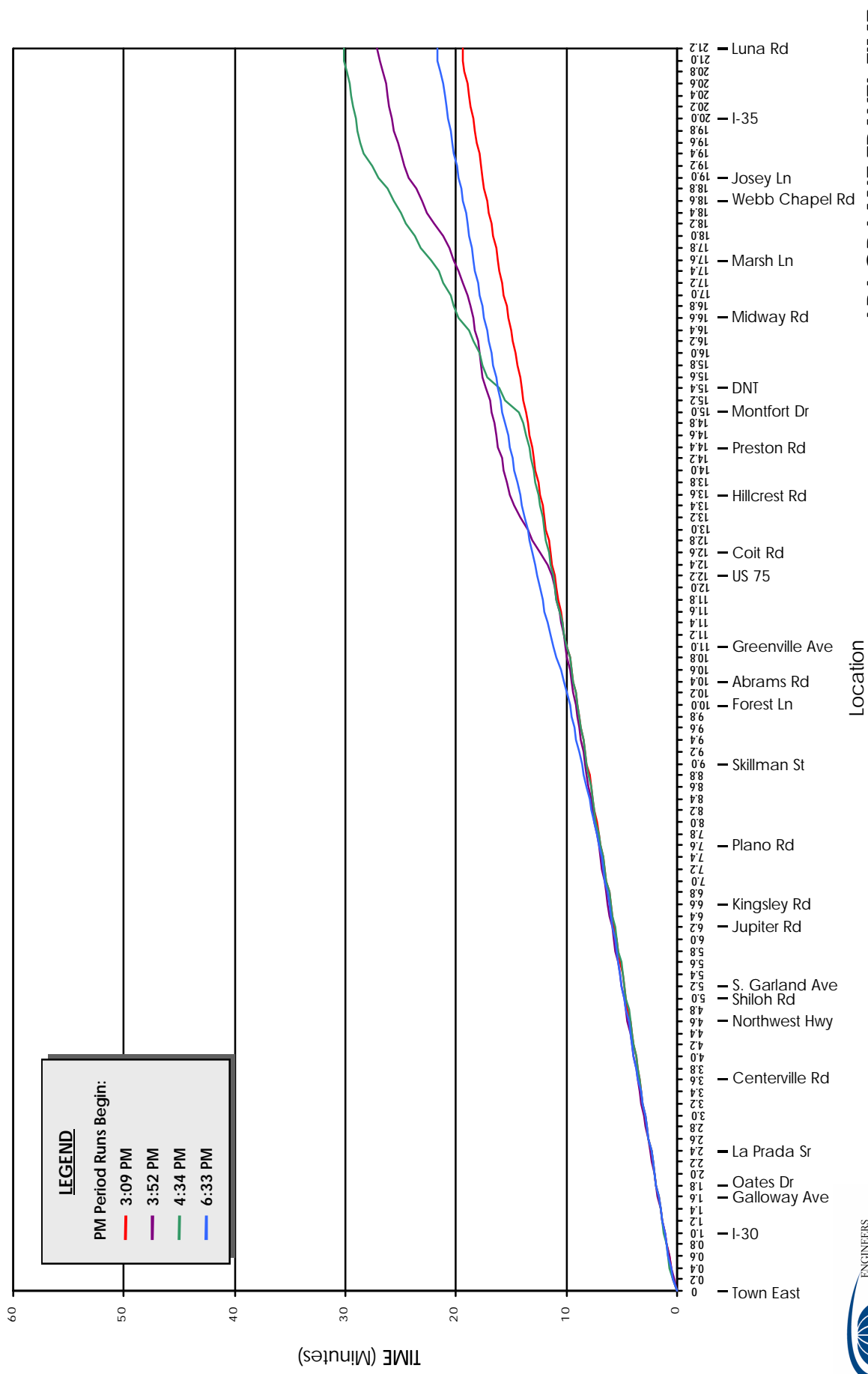
**LBJ GP LANE TRAVEL TIME
PM EASTBOUND**

FIGURE 2-9



**LBJ GP LANE TRAVEL TIME
 AM WESTBOUND**

FIGURE 2-10



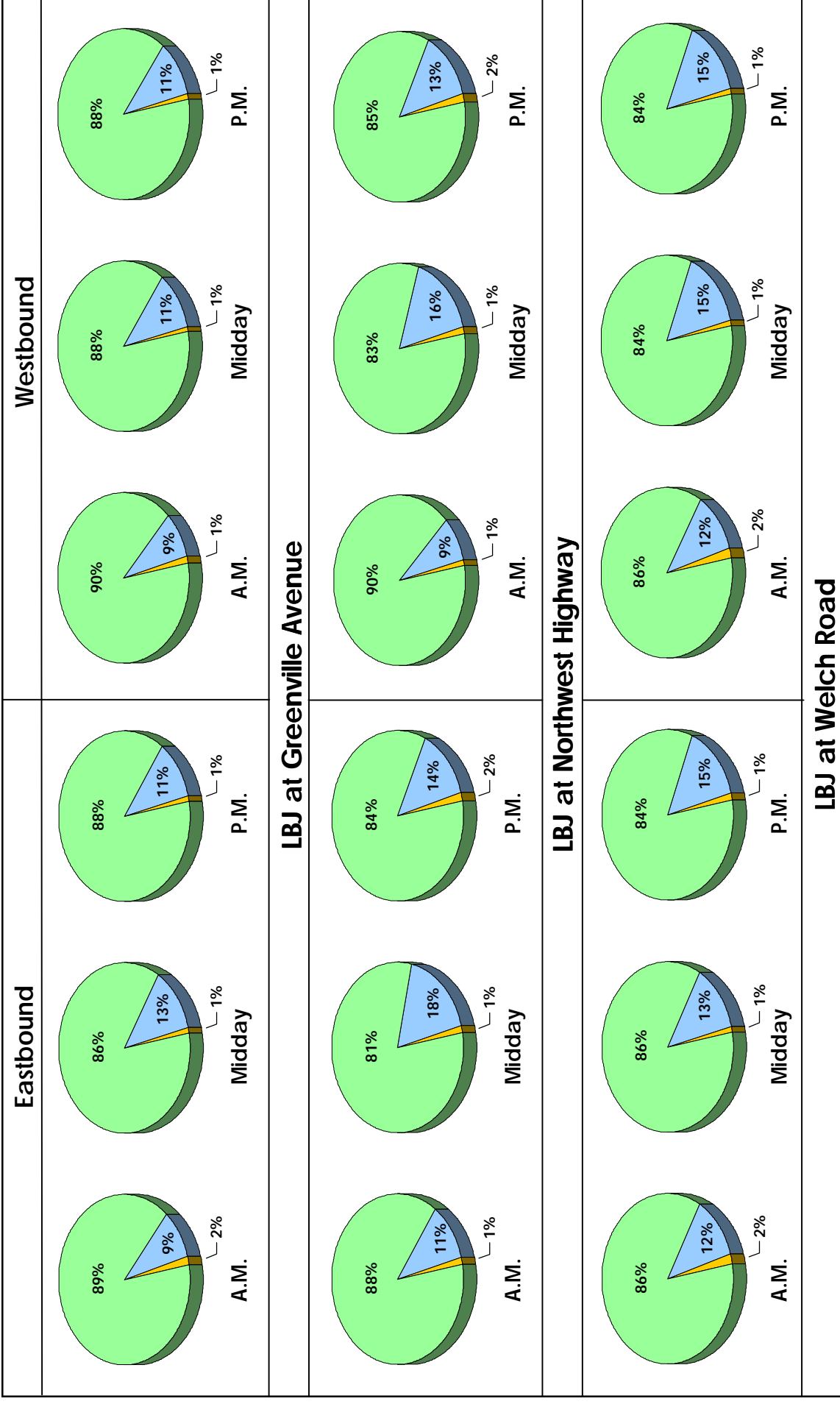
**LBJ GP LANE TRAVEL TIME
PM WESTBOUND**

FIGURE 2-11

Table 2-3
Travel Time Comparison LBJ vs. Alternate Route

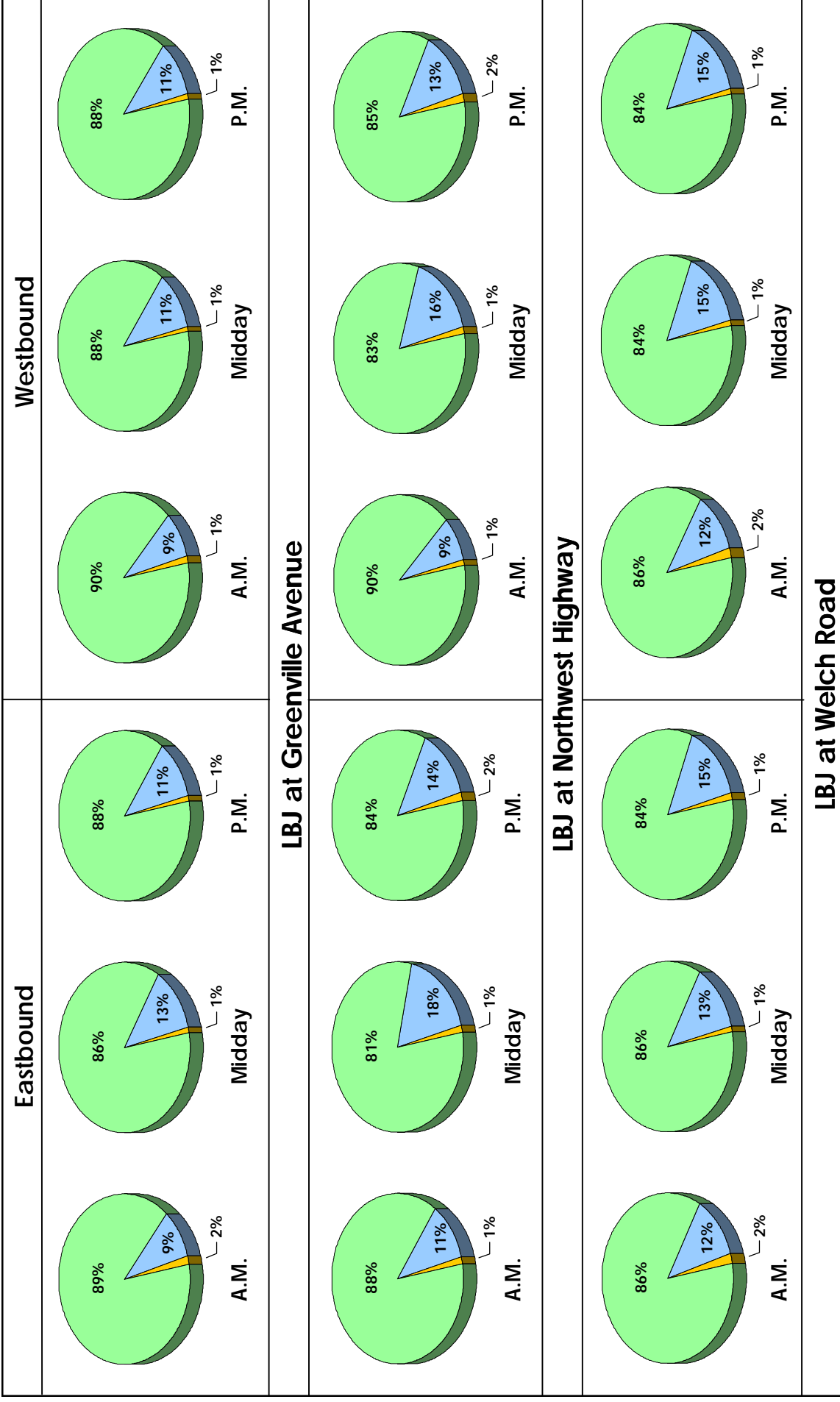
| Section | Facility | AM Peak | | | | | | PM Peak | | | | | |
|---------------------------|-----------------------|--------------------------------|--------------------------|-------------|--------------------------------|--------------------------|-------------|--------------------------------|--------------------------|-------------|--------------------------------|--------------------------|-------------|
| | | Eastbound | | | Westbound | | | Eastbound | | | Westbound | | |
| | | Arterials Travel Time (min) | LBJ Travel Time (min) | Time Saving | Arterials Travel Time (min) | LBJ Travel Time (min) | Time Saving | Arterials Travel Time (min) | LBJ Travel Time (min) | Time Saving | Arterials Travel Time (min) | LBJ Travel Time (min) | Time Saving |
| I-35E to Midway | 1) Spring Valley Road | 11.87 | 5.42 | 6.45 | 10.38 | 5.93 | 4.45 | 11.08 | 6.54 | 4.54 | 12.31 | 6.07 | 6.24 |
| | 2) Valley View Lane | 8.83 | 5.42 | 3.41 | 8.78 | 5.93 | 2.85 | 9.47 | 6.54 | 2.93 | 9.55 | 6.07 | 3.48 |
| | 3) LBJ Frontage Road | | | | | | | | | | | | |
| | 4) Forest Lane | | | | | | | | | | | | |
| | 5) North Haven Road | | | | | | | | | | | | |
| | 6) Royal Lane | 7.74 | 5.42 | 2.32 | 8.09 | 5.93 | 2.16 | 8.06 | 6.54 | 1.52 | 10.20 | 6.07 | 4.13 |
| Midway to Preston | 1) Spring Valley Road | 5.45 | 2.27 | 3.18 | 6.19 | 2.37 | 3.82 | 6.29 | 6.41 | -0.12 | 6.44 | 2.91 | 3.53 |
| | 2) Valley View Lane | 5.92 | 2.27 | 3.65 | 5.77 | 2.37 | 3.40 | 6.97 | 6.41 | 0.56 | 6.37 | 2.91 | 3.46 |
| | 3) LBJ Frontage Road | 6.44 | 2.27 | 4.17 | 6.50 | 2.37 | 4.13 | 6.27 | 6.41 | -0.14 | 9.05 | 2.91 | 6.14 |
| | 4) Forest Lane | 3.89 | 2.27 | 1.62 | 3.66 | 2.37 | 1.29 | 5.34 | 6.41 | -1.07 | 3.95 | 2.91 | 1.04 |
| | 5) North Haven Road | 5.40 | 2.27 | 3.13 | 5.16 | 2.37 | 2.79 | 5.78 | 6.41 | -0.63 | 5.34 | 2.91 | 2.43 |
| | 6) Royal Lane | 4.35 | 2.27 | 2.08 | 3.99 | 2.37 | 1.62 | 6.35 | 6.41 | -0.06 | 3.75 | 2.91 | 0.84 |
| Preston to U.S. 75 | 1) Spring Valley Road | 8.50 | 2.50 | 6.00 | 7.89 | 3.57 | 4.32 | 10.06 | 3.92 | 6.14 | 9.90 | 2.69 | 7.21 |
| | 2) Valley View Lane | | | | | | | | | | | | |
| | 3) LBJ Frontage Road | | | | | | | | | | | | |
| | 4) Forest Lane | 4.02 | 2.50 | 1.52 | 3.94 | 3.57 | 0.37 | 4.67 | 3.92 | 0.75 | 3.77 | 2.69 | 1.08 |
| | 5) North Haven Road | | | | | | | | | | | | |
| | 6) Royal Lane | 4.70 | 2.50 | 2.20 | 4.17 | 3.57 | 0.60 | 4.91 | 3.92 | 0.99 | 4.54 | 2.69 | 1.85 |
| U.S. 75 to Audelia | 1) Spring Valley Road | | | | | | | | | | | | |
| | 2) Valley View Lane | | | | | | | | | | | | |
| | 3) LBJ Frontage Road | | | | | | | | | | | | |
| | 4) Forest Lane | 6.72 | 3.13 | 3.59 | 8.65 | 6.49 | 2.16 | 9.68 | 4.13 | 5.55 | 8.53 | 3.13 | 5.40 |
| | 5) North Haven Road | | | | | | | | | | | | |
| | 6) Royal Lane | 6.27 | 3.13 | 3.14 | 7.15 | 6.49 | 0.66 | 6.61 | 4.13 | 2.48 | 8.58 | 3.13 | 5.45 |

* Negative time indicates LBJ delay relative to travel in arterials.



Note: Vehicle Occupancy Location
Without HOV Lanes

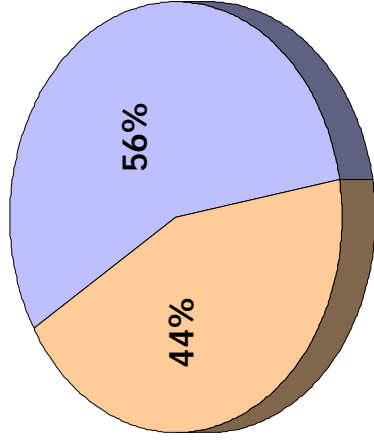
LBJ Freeway Managed Lanes Study



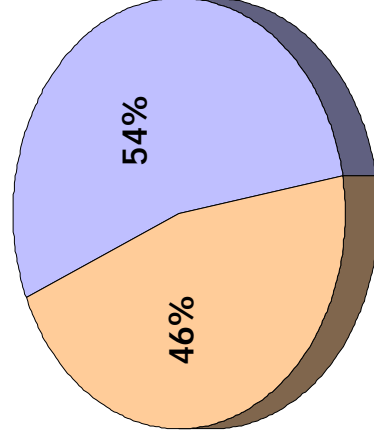
Note: Vehicle Occupancy Location
Without HOV Lanes



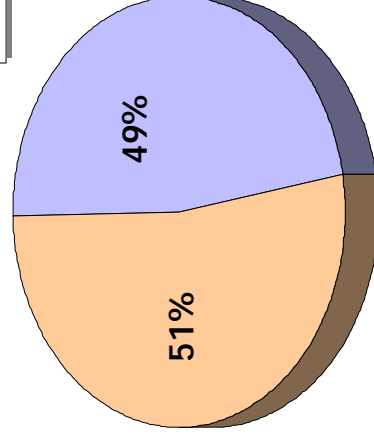
Westbound



A.M.

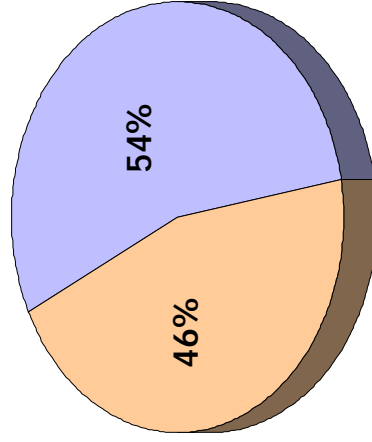


Midday

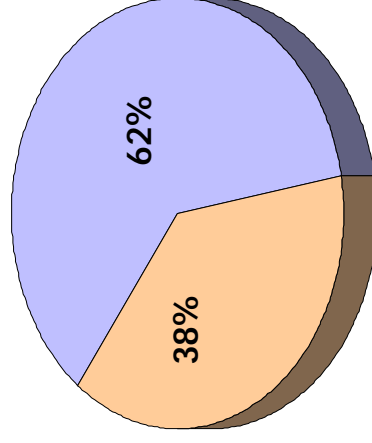


P.M.

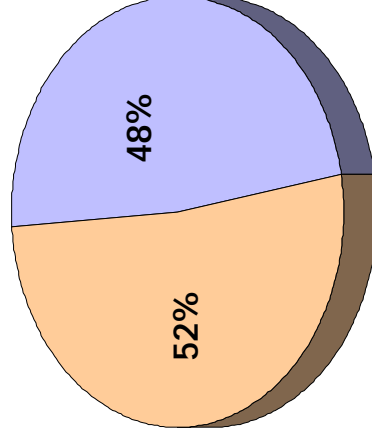
Eastbound



A.M.



Midday



P.M.

Note: Data Collected Near Welch Rd.

- ✍ Fourteen percent of the current traffic on the LBJ Freeway are HOVs and only one percent of those are HOV3+;
- ✍ The LBJ Freeway operates at or near capacity between I-35E and U.S. 75 for the A.M., Midday and P.M. peak periods;
- ✍ The empirical evidence suggests that a good portion of the LBJ is operating at LOS F for much of the time during the peak periods due to generally high traffic levels coupled with the effects of merging and weaving in the vicinity of ramps.

CHAPTER 3

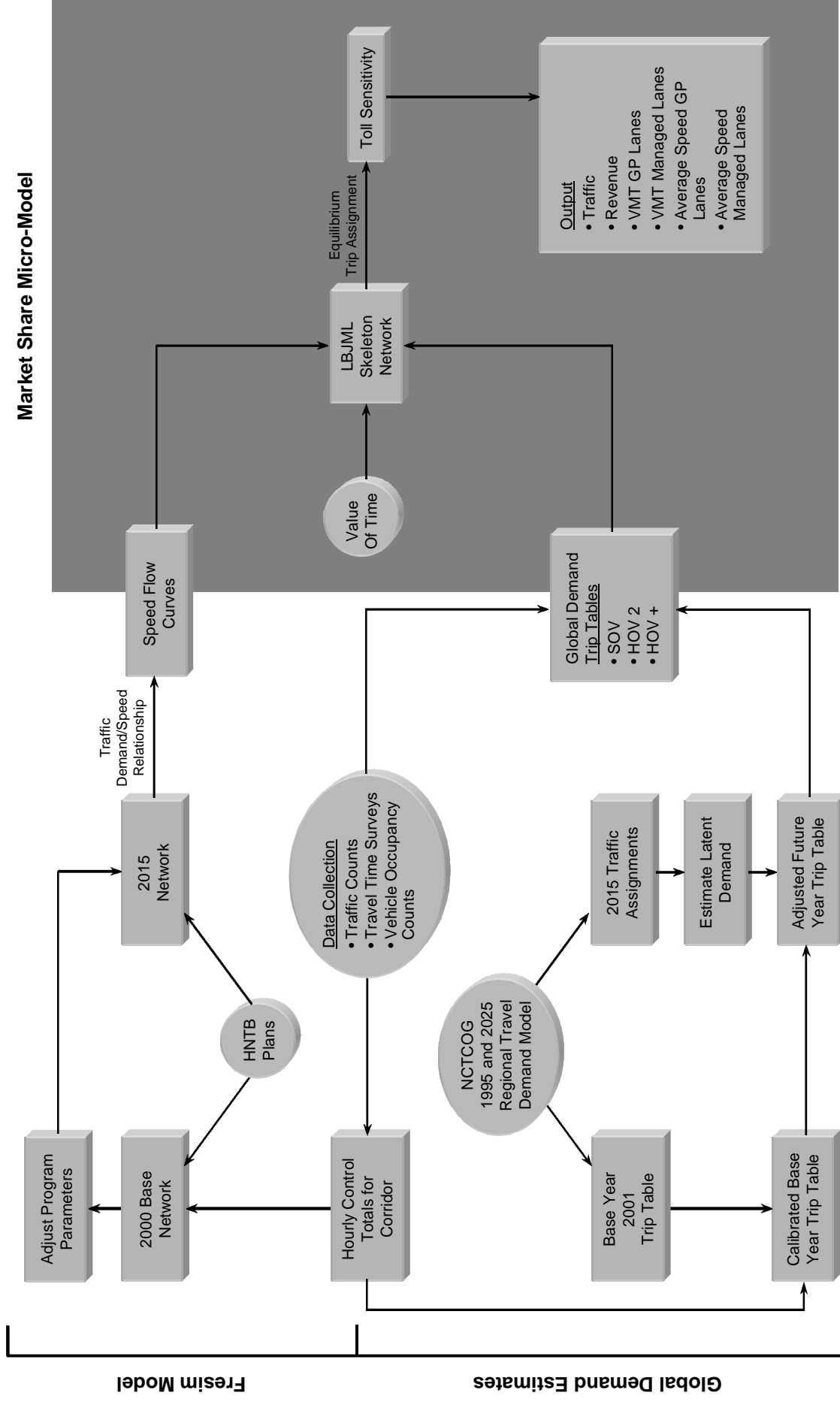
METHODOLOGY

The analysis methodology used for this Phase II study is similar to that used for the Preliminary Feasibility Study conducted earlier, with the benefit of significantly more data collected and greatly refined modeling technologies. Modifications to the overall analysis methodology were developed to make better use of the additional traffic information collected as part of this study, and to allow for a more streamlined process to analyze a larger number of scenarios.

Three levels of analysis were used to estimate traffic and toll revenue for the LBJML:

- ✍ Global Demand - The global demand represents the amount of traffic that would be using the LBJ Freeway, including both the MLs and the GP lanes under the various study scenarios.
- ✍ FRESIM - A traffic model of the LBJ Freeway GP lanes was developed using the FRESIM microsimulation program to identify changes in the travel time and delay on different segments of the LBJ GP lanes at differing levels of traffic loadings.
- ✍ Market Share Micro-Model - The market share micro-model estimates the share of the total corridor global demand that would use the LBJML vs. the GP lanes. The traffic that is estimated to use the LBJML is based on several factors, including: location of access points to the LBJML, time savings afforded over travel in the GP lanes, and toll rates to be charged.

The flow chart in Figure 3-1 shows the relationship between these three analysis components, and where the actual data collected in the corridor was used to enhance the estimates.



SCENARIOS ANALYZED

For this Phase II study, WSA was requested to estimate traffic and revenue potential for the LBJML with the following areas of variation:

- ✍ Project Configuration - Base ramp configuration vs. reduced ramp configuration;
- ✍ Free Usage - Minimum occupancy level of two-or-more vs. three-or-more occupants per vehicle for toll-free usage of LBJML;
- ✍ GP lanes - Existing lanes in GP lanes from Luna to U.S. 75 (four per direction) vs. adding one lane in each direction in GP lanes from Luna to U.S. 75 (five per direction); and
- ✍ Growth Level – A re-estimate of 2015 corridor travel levels based on a 15 percent expansion of travel on the LBJML/GP lane facility. This was a hypothetical adjustment in global demand used to test ML sensitivity to changes in global demand. While not specifically representing any year, the 15 percent growth level generally corresponds to the amount of growth currently envisioned in the NCTCOG model trip tables between 2015 and 2025. It could, however, also provide an indication as to impacts on traffic and revenue if a higher level of growth between 2000 and 2015 occurs.

These variations in project assumptions resulted in a total of 10 scenarios, as summarized in Table 3-1.

The reduced ramp configuration omits the following connections between the LBJML and the GP lanes:

- ✍ Westbound exit to Preston (via Frontage Road);
- ✍ Westbound exit to the LBJ GP lanes (near Rosser);
- ✍ Westbound entrance from Midway (via Frontage Road);
- ✍ Eastbound exit to the LBJ GP lanes (near Marsh Road);
- ✍ Eastbound entrance from Webb Chapel (via Frontage Road); and
- ✍ Eastbound entrance from Preston (via Frontage Road).

Table 3-1
Analysis Scenarios

| Scenario | Global Demand | ML Access Configuration | Toll-Free Users(1) | Number of GP Lanes(2) |
|-----------------|----------------------|--------------------------------|---------------------------|------------------------------|
| 1 | 2015 | Base | HOV-2+ | 4 |
| 2 | 2015 | Base | HOV-3+ | 4 |
| 3 | 2015 | Base | HOV-2+ | 5 |
| 4 | 2015 | Base | HOV-3+ | 5 |
| 5 | 2015 | Reduced | HOV-2+ | 4 |
| 6 | 2015 | Reduced | HOV-3+ | 4 |
| 7 | 2015 | Reduced | HOV-2+ | 5 |
| 8 | 2015 | Reduced | HOV-3+ | 5 |
| 9* | +15% | Base | HOV-2+ | 4 |
| 10* | +15% | Base | HOV-3+ | 4 |

* Re-estimated level of global demand based on 15 percent growth.

(1) Minimum occupancy level for free travel on LBJML.

(2) Number of "through" travel lanes on LBJ GP lanes from Luna Road to U.S. 75, per travel direction.

GLOBAL DEMAND ESTIMATES

The corridor global traffic demand is defined as the total traffic using the LBJ Freeway, whether on the GP lanes or on the LBJML lanes. This includes both HOV and non-HOV traffic components. WSA developed estimates of the global demand for the LBJ Freeway using data provided by the NCTCOG from its regional travel demand model.

REGIONAL TRAVEL DEMAND MODEL INPUTS

The Dallas regional highway network already being used by WSA for use in other work for the North Texas Tollway Authority (NTTA) was used to develop the global demand estimates for this study. The highway network was modified to include the current proposed LBJML base configuration. A second network, with an additional GP lane in each direction between Webb Chapel and U.S. 75 was also prepared.

The trip tables used for this analysis reflect the latest socioeconomic forecasts available for the region, developed in the 2025 Mobility Plan and adopted in January 2000. Trip tables for single- and two-or-more occupant vehicles for years 1995 and 2025 were provided by NCTCOG. These trip tables were provided for a.m. peak (6:00-9:00 a.m.), p.m. peak

(3:00-7:00 p.m.), midday (9:00 a.m.-3:00 p.m.) and night (7:00 p.m.-6:00 a.m.) analysis periods.

BASE-YEAR INTERCHANGE-TO-INTERCHANGE TRIP TABLES

Traffic assignments were run on the regional highway model in order to identify the total traffic accessing the LBJ Freeway within the project limits (Luna Road to I-30). The global demand estimates include the traffic using the LBJML as well as all traffic in the GP lanes. Interchange-to-interchange trip tables were extracted from the regional highway assignments for use with the market share micro-model. This process is performed for the a.m., p.m., midday, and night analysis periods.

Interchange-to-interchange trip tables were first developed at base-year (2000) levels. These trip tables were used as seed matrices in an adjustment process that factors the trip tables to hourly levels using hourly control totals for each interchange ramp. The GP lane segments on LBJ immediately west of Luna Road and immediately south of I-30 are also treated as entry and exit points to the system. The hourly control totals were developed from the hourly traffic profile detailed in Chapter 2. The factoring process results in calibrated base-year interchange-to-interchange trip tables that represent the total traffic traveling in the corridor during the a.m., p.m., midday, and night analysis periods.

FUTURE-YEAR INTERCHANGE-TO-INTERCHANGE TRIP TABLES

Future-year (2015) traffic assignments were made to identify potential changes in travel patterns in the corridor. These travel patterns are affected by growth in the region, the addition of new capacity to the freeway in the form of added GP lanes and the addition of the LBJML, the connection of existing frontage road segments to form a continuous system, and the closing and opening of several freeway access ramps.

A series of future-year traffic assignments were made under varying assumptions with regard to access to the LBJML. These assumptions were designed to try to take into account the potential impacts of latent demand and are discussed in detail later in this chapter. Interchange-to-interchange trip tables were extracted from each set of runs and compared to those developed for the base-year to develop growth rates for each interchange-to-interchange movement for each time period. These growth rates were then applied to the calibrated base-year matrices to develop adjusted future-year trip tables for each time period.

HOV DEMAND

Four scenarios analyzed assume free access to the MLs for vehicles with two-or-more occupants. Four additional scenarios analyzed for this Phase

II study involve free access to the LBJML lanes for vehicles with three-or-more occupants. To provide a basis of comparison between these two sets of scenarios, the interchange-to-interchange trip tables were disaggregated into SOV, HOV-2 and HOV-3+ components. For the purposes of analysis, trucks were included in the SOV component of the trip table since they, like SOVs, are toll paying vehicles under all scenarios.

The NCTCOG mode choice model forecasts only SOV vs. HOV-2+ traffic for the a.m. and p.m. peak periods only. In general, the NCTCOG model did not indicate significant changes in overall vehicle occupancy levels in this corridor, even with significant changes to the region's HOV network. However, for conservatism, WSA has assumed modest increases in vehicle occupancy levels over time, since the scenarios assume that at least one HOV component will be able to travel for free in the LBJML.

Table 3-2 summarizes the share of HOV-2 and HOV-3+ traffic assumed in the traffic stream by 2015.

| Table 3-2 Estimated Distribution of High Occupancy Vehicles by Time Period | | | |
|---|----------------------------------|--------------|---------------|
| Time Period | Percent of Total Traffic | | |
| | SOV& Trucks | HOV-2 | HOV-3+ |
| A.M. Peak | 83.2 | 14.8 | 2.0 |
| P.M. Peak | 81.2 | 17.1 | 1.7 |
| Midday | 83.7 | 14.8 | 1.5 |

LATENT DEMAND

WSA recognizes that the global demand in the corridor could be different depending on what level of access is assumed for the new lanes. For example, at the two extremes, if the new lanes were designated to be HOV-only lanes, the corridor would attract less new traffic to the Freeway than if the lanes were constructed as GP lanes. The total traffic entering the LBJ Freeway and ML system as "global demand" changes between

these two conditions as a result of the latent demand for travel in the corridor.

In the traffic assignment process, the latent demand is the amount of traffic that would like to use the LBJ, but due to congestion levels on the Freeway, uses alternative routes such as the frontage roads and parallel arterials. As capacity is added to the LBJ, traffic that would otherwise use parallel arterials returns to the Freeway. The additional capacity is absorbed until the congestion again reaches a condition where travel times on the arterials and frontage roads again becomes competitive with the Freeway.

When the new lanes are constructed as HOV-only lanes, the amount of additional capacity is limited to the amount of HOV traffic that would use the HOV lane. When constructed as GP lanes, the additional capacity would very likely be absorbed entirely. When constructed as MLs, where some lower-occupancy traffic is allowed to use the HOV lanes for a price and the price is set to maintain an acceptable level of service in the MLs, the total global demand for the LBJ falls somewhere in between these two conditions. The pricing mechanism, in effect, controls the amount of new capacity “available for use” in order to maintain favorable operating conditions.

This distinction in the global demand under the different usage assumptions is important since the total global demand affects the level of congestion in the GP lanes on the LBJ Freeway. The level of congestion in the GP lanes, in turn, directly affects the amount of time savings offered by the MLs, which determines the amount of traffic willing to pay a toll.

If the tolls for the MLs were set very high, the amount of traffic in the MLs would be low, and would begin to resemble the HOV-only condition, with a lower total global demand. If the tolls for the MLs were set very low, they would begin to fill up and could become as congested as the GP lanes, with a higher total global demand.

To take the variation in global demand into account in this analysis, WSA ran the Dallas regional travel demand model under two different assumptions regarding usage of the LBJML. Under one assumption, the LBJML was assumed to be open to HOV-2+ traffic only. This was used to represent a condition under which higher tolls are charged for use of the MLs, to the point where toll-paying traffic is essentially priced out of the MLs. Under the second assumption, the LBJML was assumed to be open to all traffic. This was used to represent a condition under which lower tolls are charged for use of the MLs. In both cases, access to the LBJML

was assumed to be limited to those locations shown in Figure 1-2 for the base configuration. Therefore, many short distance trips that are identified in the trip tables, and whose drivers may have wanted to pay a toll, were still not able to use the MLs, because of configuration constraints. However, these trips could be more readily accommodated in the GP lanes as capacity is freed up by longer-distance traffic shifting to the LBJML.

At 2015 levels, on an average daily basis, the difference between the lower global demand (high toll condition) and the higher global demand (lower toll condition) was about 10 percent for Scenarios 1,2,5, and 6. When an extra lane was assumed in the GP lanes (Scenarios 3,4,7, and 8), the total number of trips in the LBJML system increased by about 3 percent in the lower global demand case and 2 percent in the higher global demand condition.

WSA then tested the level of toll that would be considered high enough to represent the “higher toll” condition by gradually increasing the toll rates charged for the LBJML until the usage of the MLs was similar to the HOV-only levels. The results of this testing are noted in Table 3-3.

Table 3-3
Maximum Toll Level Represented by Higher Global
Demand Estimates

| Analysis | | Scenario | |
|--|------------------|-----------------------------------|-----------------------------------|
| | | 4 GP Lanes (Scenarios 1,2,5,6) | 5 GP Lanes (Scenarios 3,4,7,8) |
| Period | Direction | | |
| A.M. | Westbound | \$0.40 per mile | \$0.40 per mile |
| | Eastbound | \$0.40 per mile | \$0.40 per mile |
| P.M. | Westbound | \$0.40 per mile | \$0.40 per mile |
| | Eastbound | \$0.50 per mile | \$0.50 per mile |
| Midday | Westbound | \$0.40 per mile | \$0.40 per mile |
| | Eastbound | \$0.60 per mile | \$0.60 per mile |
| <hr/> Note: These rates do not reflect tolls used in calculating traffic and revenue estimates. | | | |

A series of trip tables were then developed to represent the variable global demand at each \$0.05 increment from \$0.10 per mile to \$0.40 per mile by interpolating between the “higher” trip table (assuming that it represents a

toll-free condition) and the “lower” trip table (assuming that it represents the toll levels shown in Table 3-3). These global demand trip tables were used in the market share micro-model to determine the amount of traffic eligible to use the LBJML and to estimate the level of congestion in the GP lanes.

FRESIM MODEL

As noted in Chapter 2, much of the recurring peak period congestion on the LBJ Freeway is the result of merging and weaving traffic movements associated with on- and off-ramps and not necessarily due to capacity limitations. Traditional traffic assignment models do not replicate well the impact of merging and weaving maneuvers on freeway capacity, nor can they reflect the impact of downstream queuing on freeway segments.

WSA has used a microscopic simulation model called FRESIM, developed by FHWA, to estimate the travel speeds on the Freeway. FRESIM attempts to model each vehicle as a separate entity. The roadway geometry and interaction with other vehicles influence the behavior of each vehicle in the model. A certain level of randomness in vehicle behavior is also introduced since each vehicle is modeled individually.

An electronic model of the LBJ Freeway and the LBJMLs was developed for this Phase II study based on the current base configuration using plans provided by HNTB. Two networks were developed, one representing the current freeway configuration, and one representing the 2015 freeway configuration. The current freeway configuration was used to test the appropriateness of program parameters and to calibrate program options. The base-year runs were compared to the actual operating profiles collected for this study with regard to average speeds along different sections of the highway and locations of queuing and delay. Program parameters were adjusted as needed to better replicate actual operating conditions. These adjustments were then carried through into the analysis of future conditions.

In the original preliminary feasibility study, a direct interactive iterative process was used between the FRESIM model and the market share model. A modified approach was developed for this study due to the need to analyze a larger number of scenarios in an efficient and effective manner.

Rather than using the FRESIM output directly in an interactive process with the market share model, a series of runs were made assuming gradually diminishing traffic loadings in the LBJMLs. As traffic in the LBJMLs decreased, the amount of traffic in the GP lanes increased, resulting in higher congestion levels in the GP lanes. A total of ten runs were made for the a.m. and p.m. peak periods for each direction. Within each time period, for each link, a relationship was developed between the “traffic demand” on the link and its modeled travel speed. By graphing the relationship between traffic demand and travel speed for all ten runs for each mainline segment WSA developed volume-delay curves for each mainline link. By comparing the curves developed for each link WSA was able to identify groups of links with similar operating and delay characteristics.

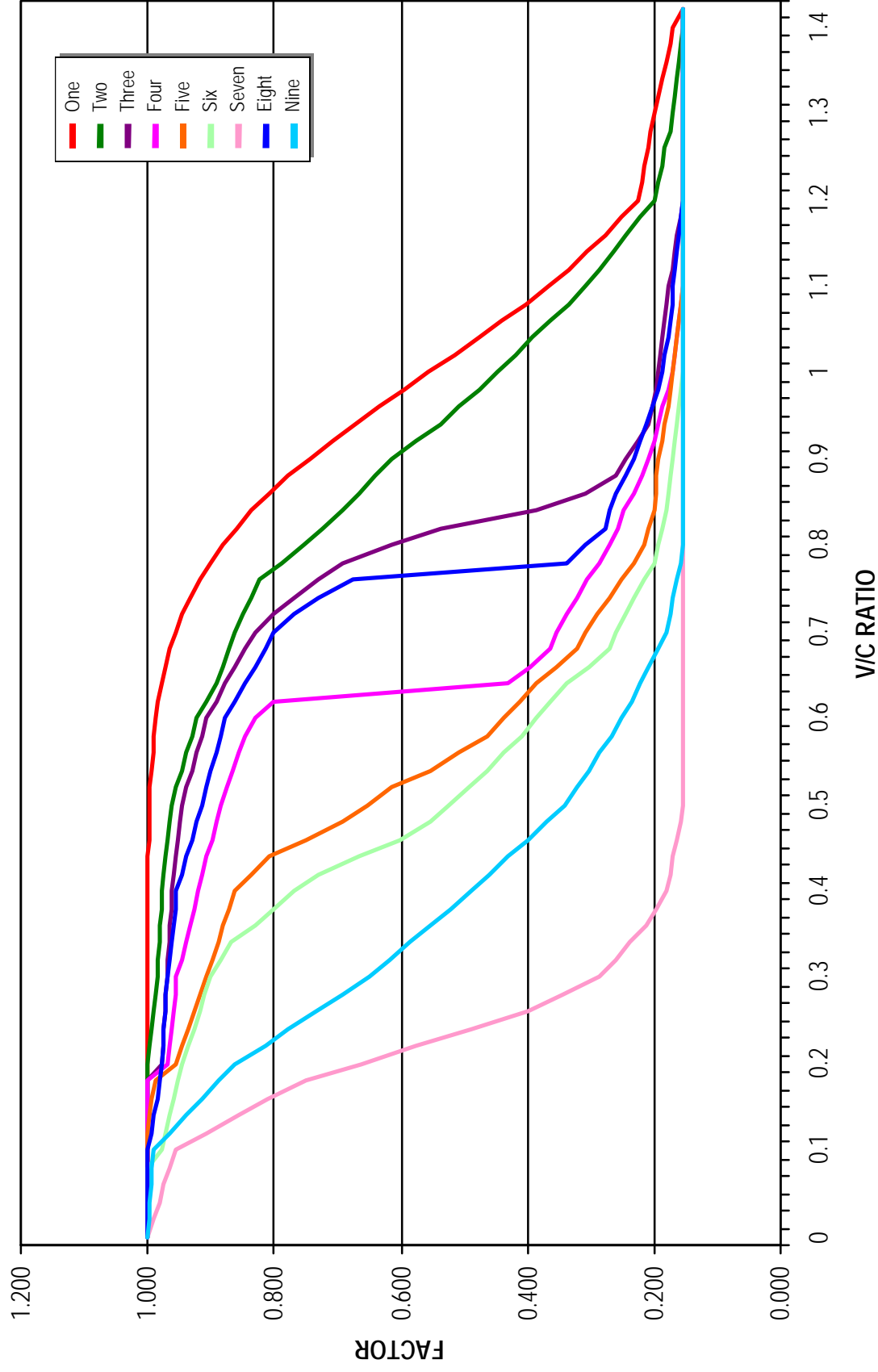
WSA then developed ten separate speed-flow curves to represent the delay characteristics on all the freeway links. Each link in the micro-model was then tagged with a user code to identify which curve should be used to estimate travel speeds for that link. Links with less weaving and merging tended to be able to accommodate higher traffic volumes at higher speeds before breaking down. Certain sections of the freeway, which may have a large entering ramp volume, tended to break down at lower demand levels, and also may break down more quickly. Other sections of freeway may appear to break down at relatively low levels of demand, but may actually be affected by downstream congestion and long queues.

A separate series of curves were developed for each time period since the operational characteristics of a link may differ between the a.m. and p.m. peak period due to the directional peaking of demand. The curves for the a.m. peak period are shown in Figure 3-2. Curves were also developed for the p.m. peak and midday conditions but are not shown.

MARKET SHARE MICRO-MODEL

A micro-model network of the LBJ was developed for the market share analysis. This micro-model of the LBJ includes the GP lanes and the MLs. Two different skeleton networks were developed, representing the base project configuration and the reduced ramp configuration. In both, the LBJMLs were coded to reflect the reversible operation of the section between Miller Road and I-30.

The micro-model was implemented using a version of the TRANPLAN assignment package specially modified by WSA for use in toll project evaluation. In the micro-model, all entering and exiting ramps were treated as centroids, which load traffic into the freeway system. The



traffic in the global demand interchange-to-interchange trip tables is loaded onto the skeleton network.

By using this type of network, changes to the access locations can be tested relatively quickly. If an access point is relocated to a different segment, the network links can be easily modified and the assignment program can build new paths between interchanges to take the change into account.

In the assignment algorithm, two paths between interchanges are built - one using the LBJML for movements that are long enough to take advantage of the new lanes, and one representing the freeway. This component of traffic is called the eligible traffic, or the market for the LBJML. Shorter movements that enter and exit between LBJML access points cannot use the LBJMLs and are considered ineligible and were assigned only to the GP lanes.

As noted in an earlier section, each link of the skeleton network was assigned a code that identified it as having one of ten groups of operational characteristics defined in ten speed-flow curves. As traffic is assigned to each link, the travel time/speed on the link is adjusted based on the volume-to-capacity ratio and the link's speed-flow curve.

For each interchange-to-interchange movement, the proportion of motorists expected to use the LBJML is a function of the computed timesavings and the cost to use the lanes (cost-per-minute saved) vs. the value placed on timesavings by the motorist (value of time or VOT). The average VOT used for this analysis was developed based on recent work done by WSA for the NCTA and reviewed for reasonableness for use in this corridor. The average value of time for corridor drivers was assumed to be \$0.21 per minute for this study.

The share of each eligible traffic movement that is captured by the LBJML is based on an estimate of the distribution of the VOT of the eligible traffic. While the average VOT is one important input, the proportion of motorists with VOT higher or lower than the average value determines the proportion that would pay to use the MLs. Motorists with a VOT greater than the cost-per-minute saved would tend to choose the MLs while those with a lower VOT would tend not to choose the lanes. Different VOT were used for peak and off-peak time periods.

The model relies on a sensitive equilibrium condition between the cost and the timesavings. If more traffic uses the MLs, there is less congestion in the GP lanes and lower timesavings. Fewer timesavings would result in

less traffic choosing the MLs. For each toll rate level, there exists an equilibrium point between the level of traffic congestion in the GP lanes (time savings) and the amount of traffic willing to pay a toll to save that same amount of timesavings. At low toll levels, there is a higher propensity to use the MLs, and there is a lower congestion level in the GP lanes. At higher toll levels, there is less traffic in the MLs and also more congestion in the GP lanes.

Within the micro-model, all three traffic components, SOV, HOV-2, and HOV-3+, for all eligible movements, are assigned simultaneously until an equilibrium condition is reached for that particular toll rate. When an HOV component is allowed free access to the LBJML, the cost-per-minute saved for this traffic is zero, and the maximum usage level is allowed for this traffic. The same global demand assumptions are used for the HOV-2+ and HOV-3+ free scenarios, but there is less free traffic in the MLs under the HOV-3+ free scenarios.

All the combinations of assumptions represented by the various scenarios were analyzed within the micro-model by changing network characteristics, such as link capacities and connections, or the tolling assumptions. The estimates of traffic usage of the LBJML and potential toll revenue come directly from the micro-model outputs.

CHAPTER 4

TRAFFIC AND TOLL REVENUE ESTIMATES

The results of WSA's assessment of the travel and revenue characteristics of the proposed LBJMLs facility are presented in this chapter. The initial set of eight scenarios that WSA was asked to evaluate was enlarged to include two others which reflected growth in travel on the facility above 2015 levels. Without this dynamic dimension of facility performance, it was felt that effective policy analysis would be severely limited.

The 10 scenarios that were eventually analyzed are listed in Table 4-1.

The scenarios created for this study by the study team were designed to provide a broad cross section of policy and operational alternatives. As shown in Table 4-1, they reflect two different levels of travel in the corridor, i.e., 2015 base forecast and a hypothetical travel scenario scaled as a 15 percent higher global demand scenario as discussed below. (The 2015 global travel demand was derived from NCTCOG's regional forecast for population and employment.) They also represent two different design configurations, i.e., a Base Access and a Reduced Access.

As shown previously in Figure 1-2 (Chapter 1), on the eastbound side of the facility, the exit ramp in the vicinity of Webb Chapel Road, the entrance ramp in the vicinity of Marsh Lane and the entrance ramp in the vicinity of Hillcrest Road are present in the Base Access configuration and absent in the Reduced Access configuration. On the westbound side of the LBJML facility, the entrance ramp in the vicinity of Marsh Road, the exit ramp in the vicinity of Midway Road and the exit ramp in the vicinity of Hillcrest Road are present in the Base Access configuration and absent in the Reduced Access configuration.

Table 4-1
Analysis Scenarios

| Scenario | Growth Level | Ramp Configuration | HOV Definition(1) | Number of GP Lanes(2) |
|-----------------|---------------------|---------------------------|--------------------------|------------------------------|
| 1 | 2015 | Base | HOV-2+ | 4 |
| 2 | 2015 | Base | HOV-3+ | 4 |
| 3 | 2015 | Base | HOV-2+ | 5 |
| 4 | 2015 | Base | HOV-3+ | 5 |
| 5 | 2015 | Reduced | HOV-2+ | 4 |
| 6 | 2015 | Reduced | HOV-3+ | 4 |
| 7 | 2015 | Reduced | HOV-2+ | 5 |
| 8 | 2015 | Reduced | HOV-3+ | 5 |
| 9* | +15% | Base | HOV-2+ | 4 |
| 10* | +15% | Base | HOV-3+ | 4 |

- (1) Minimum occupancy level for free travel on LBJML.
 (2) Number of directional "through" travel lanes on LBJ main lanes from Luna Road to U.S. 75.
 (3) Re-estimated Global Demand based on 15% growth

Two HOV incentive/tolling frameworks were proposed for evaluation: HOV-2+ and HOV-3+. HOV-2+ refers to a tolling alternative that would allow HOVs with two or more people to ride free along with bus transit and emergency/police vehicles. HOV-3+ refers to a tolling alternative that would allow HOVs with three or more people to ride free along with bus transit and emergency/police vehicles.

SOVs would pay a toll to use the LBJMLs under all tolling alternatives. It was assumed that LDTs would be treated like SOVs for tolling purposes, while HDTs might be allowed to buy into the MLs as capacity permitted. This would likely be in the off peaks and in the early years of operation, but was not evaluated in detail in this study.

Two different capacity levels for the GP lanes were also tested within the overall framework outlined above, i.e., four lanes per direction and five lanes per direction.

INCREASED GROWTH SCENARIOS

Scenarios 9 and 10 shown in Table 4-1 reflect a hypothetical increase in global demand on the LBJ lanes. The basic work plan for this study envisioned all traffic and revenue estimates would be made at 2015 levels, which would reflect an early year in the operations of the project. However, given the nature of ML facilities, such as those proposed for LBJ Freeway, there is typically a very high sensitivity between changes in global demand for the overall freeway corridor and changes in traffic and revenue on the MLs themselves.

This is due to the fact that early in the life of a MLs project, the new toll capacity is likely to accommodate only a small share of potential future demand. However, the MLs will represent a large portion of available capacity for future growth. Therefore, as global demand increases, the share of traffic choosing to use the MLs will increase, translating into a rate of growth in the use of the MLs which may be several times the multiple of global demand growth in the corridor.

As a way of estimating the sensitivity of traffic and revenue forecast on the LBJMLs facility to changes in global demand, a hypothetical increased global demand forecast scenario was developed. This was used in Scenarios 9 and 10. It was developed by simply increasing the calibrated 2015 micro model trip tables for each analysis period by a nominal 15 percent.

In practice, the 15 percent net change is comparable to the approximate level of change in the NCTCOG trip tables between the years 2015 and 2025. Therefore, in one sense, this higher growth condition might be considered indicative of a future year, 2025. However, the analysis was not made using the actual 2025 trip table from NCTCOG, but rather the hypothetical 15 percent nominal increase which was intended only to illustrate sensitivity of revenue potential on the MLs to future growth conditions, whenever that may occur.

Since this study was not an investment-grade assessment of traffic and revenue, WSA was not asked to evaluate the economic growth levels that underpin the travel estimate for the corridor. Therefore, our team was not able to support an increase in travel with a detailed evaluation of the regional economy.

While the hypothetical figures used are generally consistent with overall regional travel forecasts for 2025, it is conceivable that they also reflect what would happen to LBJMLs traffic and revenue if growth between 2000 and 2015 were, say, increased by 1 percent per year over the nominal

base forecast included in the NCTCOG model. *To be clear, this scenario is not the result of a full economic assessment of the regional forces at work, and therefore is offered only as a presentation of the impact of a hypothetical increase in global demand on traffic and revenue of the MLs facility.* However, WSA believes that the issue of economic and travel growth in the corridor should be revisited in much more detail as the LBJML project moves further toward ultimate implementation and finance.

ADJUSTMENTS FOR INTERMODAL TRANSFERS AND FREQUENT BURGER MILES

A modest revision of both the base 2015 and high growth (future year) travel estimates for the facility was made to include the effects of multi-modal trip opportunities that are created as a result of the construction of the LBJML along with the construction of several rail and transit facilities in the vicinity of or directly connected to the LBJML, see Figure 1-2. Prior to the construction of these facilities, the possibility for multimodal trips in this corridor was next to non-existent. To accommodate this new travel possibility in the trip tables, a relatively modest 800 trips per day were added to the future trip levels.

Another, more significant, multi-modal trip generation feature is created by the LBJML's potential for innovative pricing strategies. The likely widespread use of ETC tolling equipment on the LBJML as well as the other major priced facilities in the region will permit the region's transport policy planners to consider the institution of cross subsidized or cross incentivized pricing for multi-modal trip choices.

The term cross subsidization/incentivization is meant to convey the opportunity ML use via a practice that is well established in marketing goods and services in general economy. It is merely offering a discount on one service, because one uses another. This can be some for a number of reasons, and with the advent of ETC via smart cards, this practice can be brought to the field of transport facility pricing too.

One should not be surprised in the not too distant future to see Frequent Burger Miles (FBMs) offered by a major hamburger chain for use on the LBJMLs. The FBMs would be earned by buying hamburgers. As one-bought burgers, one's "cash" in a toll account on a smart card would increase. The use of the FBM by a driver on the LBJML would complete a transaction by transferring that "cash" to the LBJML account. This money would have essentially been paid by the burger chain to the LBJML operators, and burger consumption was thereby translated at some conversion rate into travel toll use. Marketing opportunities abound in the smart card future; the reader is left to her own imagination.

A more mundane version might see, for example, incentivized (discounted) travel on DART rail and bus services if use of the LBJML facility were made. HOV users might get a piece of this action as well in that they would be delivering more riders to the DART system in a modal format that required fewer of the hard-to come-by parking spaces per paying rider. Numerous others cross subsidization/incentivization pricing strategies are available to the region's facility operators, some of which were discussed in Chapter 1.

An estimate for this effect on travel levels on the LBJML facility was not made for this study. It was felt that the potential impact for this type of pricing policy could be great and therefore a less than thorough analysis might not do justice to the opportunity it presented. Therefore, no estimate of the impact of this option on travel on the LBJML facility was included in this study. As such, we recommend that such an analysis be undertaken by the interested parties prior to the opening of the LBJML facility so that a better understanding of the effects this pricing strategy can have on facility use.

As noted earlier in the introduction to this report, the Managed Lane transport platform has the ability to support Bus Rapid Transit as well. While active planning to implement this service format on the LBJML is not underway, it is a format of service that could have very significantly impact travel and development in the corridor. A discussion of this potential occurs later in the report, but it should be noted that should coordinated development strategies be coupled to the LBJ/BRT scenario, substantial increases in development attendant to that notion would generate increased travel in the corridor and on the LBJML facility.

If it were determined to proceed with this type of BRT service/real estate development strategy, it is not felt by the study team that this would not reduce SOV or HOV travel on the facility. The study team holds this position, because this type of service generally contains the ability to incentivize growth levels and density levels such that overall trip levels for all modes would likely increase substantially even while some trips were being converted from SOV or HOV to transit.

Should development strategies be pursued in concert with BRT to a levels achievable/experienced elsewhere, one could reasonably expect, based on the results achieved elsewhere, that total travel would increase markedly on the facility for all modes.

TOLL SENSITIVITY ANALYSIS

Each of the 10 project alternatives was evaluated under several different toll rates, separately by direction for a.m. peak, p.m. peak and midday conditions. A summary of the results of this toll sensitivity is presented in Figures 4-1 through 4-3. Because of the unique operating characteristics of MLs, optimum tolls, the rate, which produces maximum revenue potential, will be different between peak and off-peak periods and possibly by travel direction within a given period. As shown in the toll sensitivity figures, the optimum toll rate also varies between project scenarios for a variety of reasons. The revenues for each scenario are depicted for a range of tolls, and curves represent the revenues collected over the entire facility for each defined direction and time period for each of the scenarios as specified.

For purposes of clarity of presentation, only five scenarios are presented in a given chart so that two charts are needed to present all scenario outcomes for a given time period. To further aid in the presentation of the ten scenarios, the scenarios are aggregated by whether they refer to HOV-2+ or HOV-3+ riding free on the ML portion of the LBJ. So on any given chart pair, each chart would have five scenarios represented for a given period and a given HOV based tolling strategy.

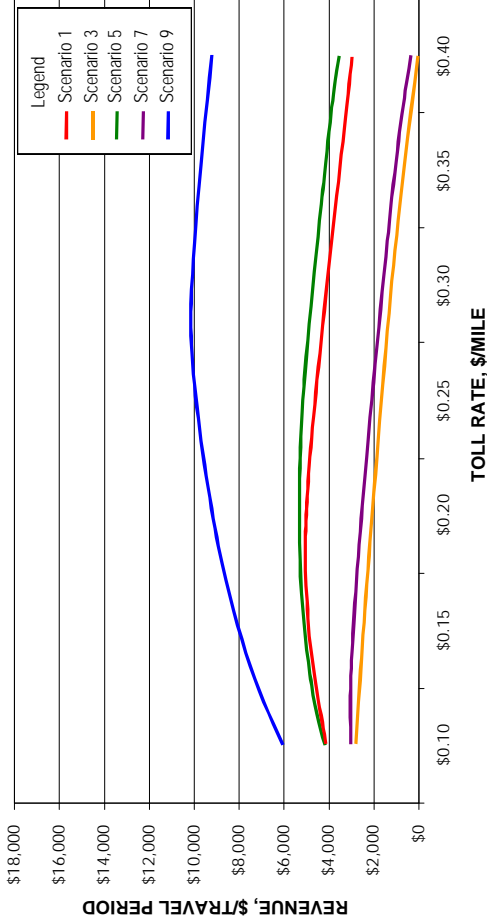
One chart, for example, shows the eastbound revenues as compared to toll rates for five scenarios in the period and the one next to it would show the westbound revenues for the time period in question. The five scenarios related to HOV-2s riding free are presented above those for the corresponding set of five scenarios for HOV-3 or more riding free.

As shown in Figure 4-1, the a.m. Period Revenues for five scenarios related to HOV-2+ for the eastbound side are presented for the a.m. period. These are Scenarios 1, 3, 5, 7, and 9. On the right side of the figure, the same scenarios are presented for the westbound direction.

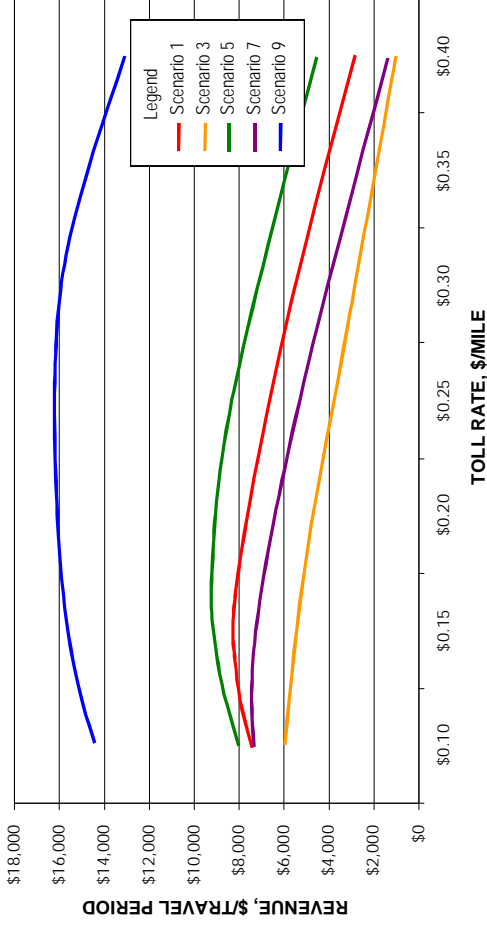
Under this set of charts, the five curves that refer to HOV-3+ for the same a.m. time period are presented, respectively, for both east and westbound directions. Together these four charts show that in the a.m. period, all ten scenarios yield higher revenues, respectively, in the westbound direction as compared to eastbound, see Figure 4-1. The maximum revenue generating toll rate differs by direction and by scenario, and that, quite expectedly, total revenues for HOV-3+ far exceed those of HOV-2+ for each corresponding set of scenarios.

LBJ Freeway Managed Lanes Study

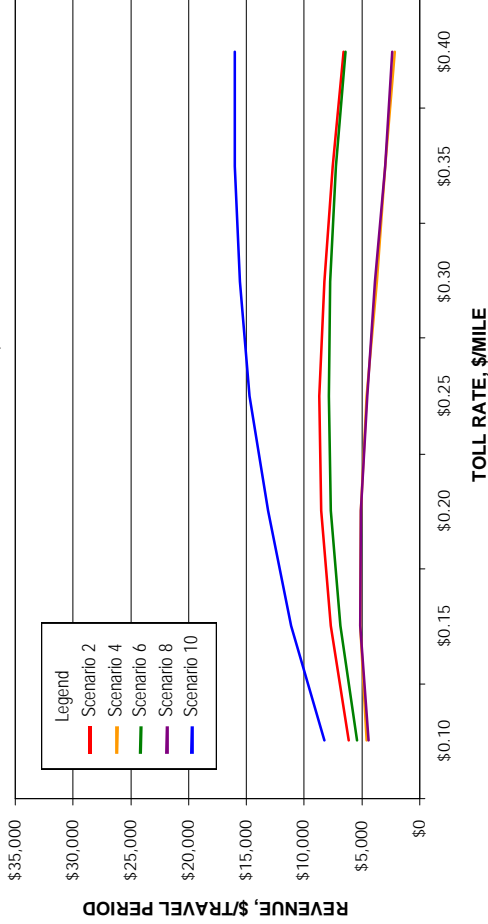
A.M. Period Eastbound Revenue, HOV2 + Free



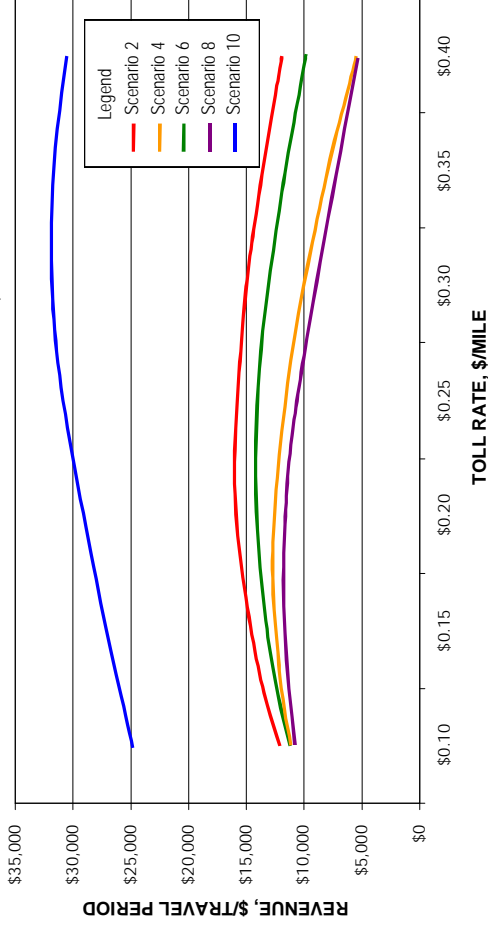
A.M. Period Westbound Revenue, HOV2 + Free



A.M. Period Eastbound Revenue, HOV3 + Free



A.M. Period Westbound Revenue, HOV3 + Free



TOLL SENSITIVITY CURVES
A.M. Period (6:00 A.M. - 9:00 A.M.)

Under Scenario 1, under which vehicles with two or more occupants would be free, maximum a.m. eastbound revenue would appear to be produced at toll rates of approximately \$0.15 per mile. However, under Scenario 9, with the hypothetical 15 percent increase in global demand, the optimum toll would be increased to about \$0.37, with a substantial increase in total revenue potential.

A similar pattern is shown between scenarios in the westbound direction. In general, westbound revenue potential in the a.m. period would typically exceed eastbound which is consistent with the relative traffic levels shown previously in Chapter 2.

Figure 4-2, shows the same information for the Midday period. Here, a number of the curves on the charts show scenarios with revenues falling to zero at the higher levels of toll rates.

This is to be expected, since during the Midday period there is substantially less traffic and correspondingly less time savings are achieved through the use of the MLs. Given the region's VOT, it is to be expected that at these low levels of time savings, very few, if any will choose to use the MLs at the upper levels of tolling

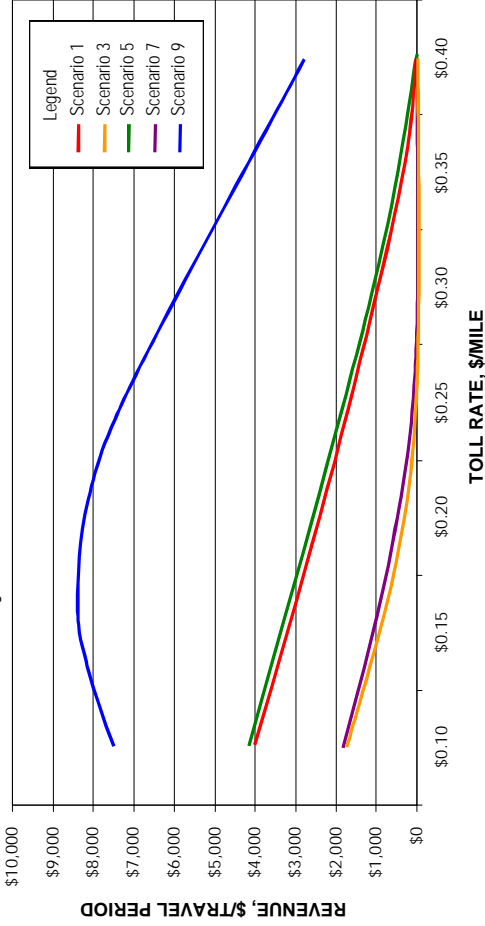
In this time period, however, the overall relationships from the previous page do not hold. While, as one would expect with all HOVs riding free, the revenue collected is uniformly less than when HOV-2 must pay a toll, yet when one compares east and westbound revenue levels there is no real superiority between east and westbound directions. In fact, at optimal levels of tolling, they are approximately equal.

Figure 4-3 portrays revenues for the p.m. period. These charts show the directional bias reversed, and the revenue levels in the p.m. period are uniformly higher across all scenarios as compared to the a.m. period.

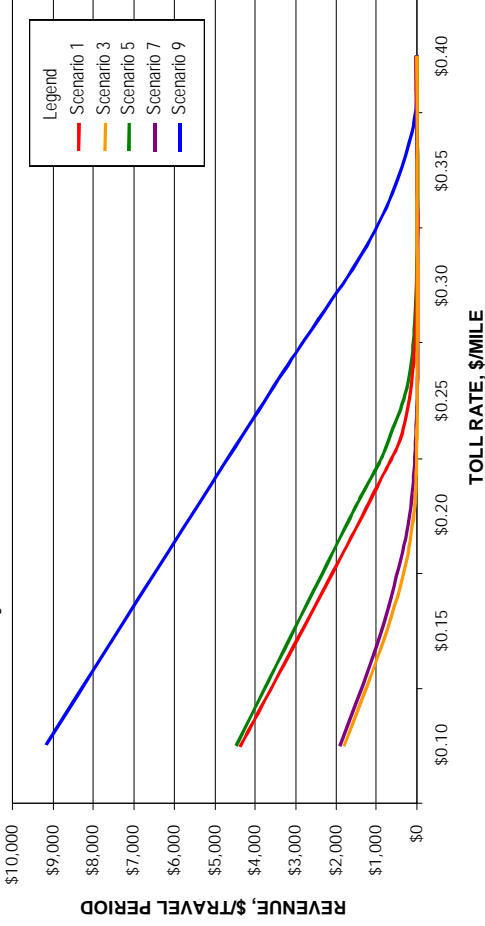
In most cases, the optimum toll for a given scenario is higher in the p.m. peak period than the a.m. peak period, and of course much higher than the midday period. For example, under Scenario 2, which assumes only vehicles with three occupants are exempt from tolls, the optimum eastbound p.m. peak toll is about \$0.25 per mile. When compared to Scenario 10, which has the same occupancy assumptions but recognizes a 15 percent increase in global demand on the LBJ Freeway, the optimum toll shifts to closer to \$0.35 per mile, with a sizable increase in toll revenue potential.

LBJ Freeway Managed Lanes Study

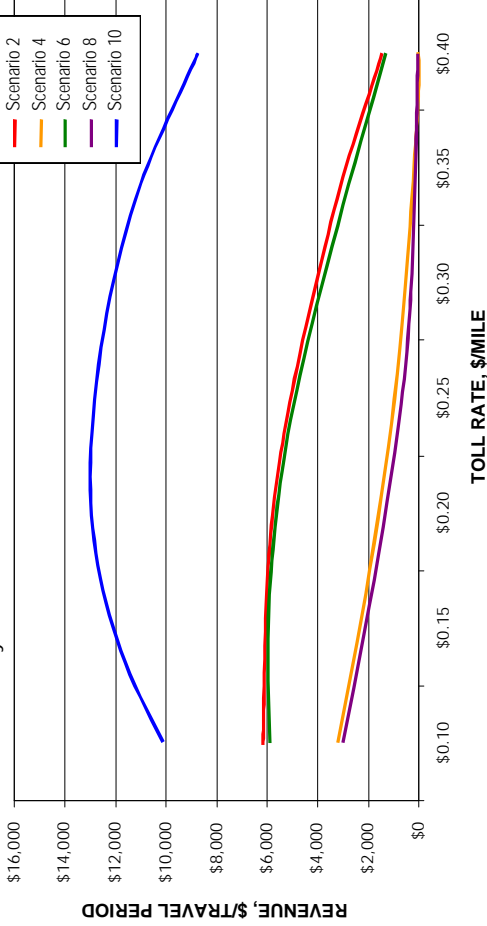
Midday Period Eastbound Revenue, HOV2 + Free



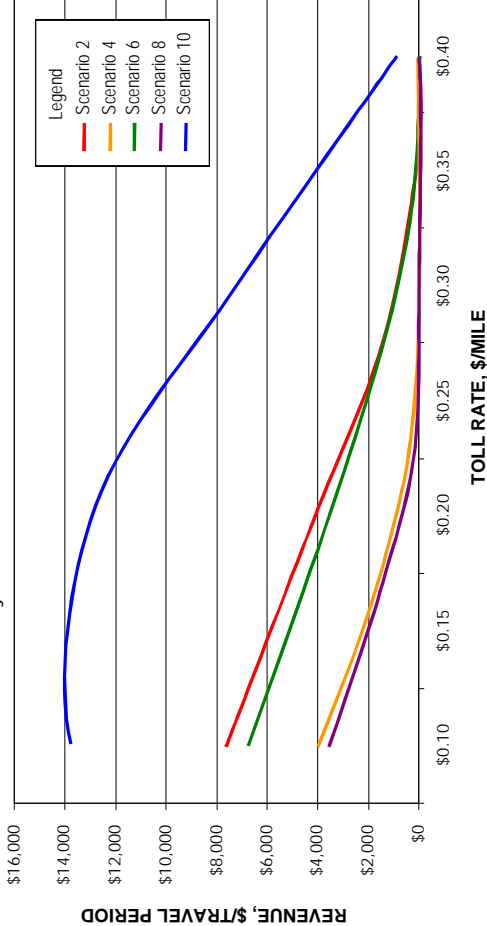
Midday Period Westbound Revenue, HOV2 + Free

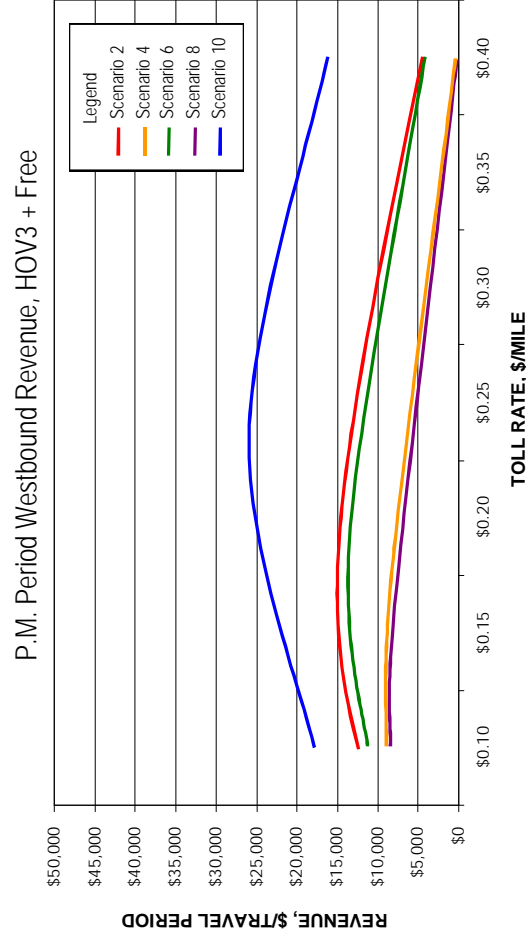
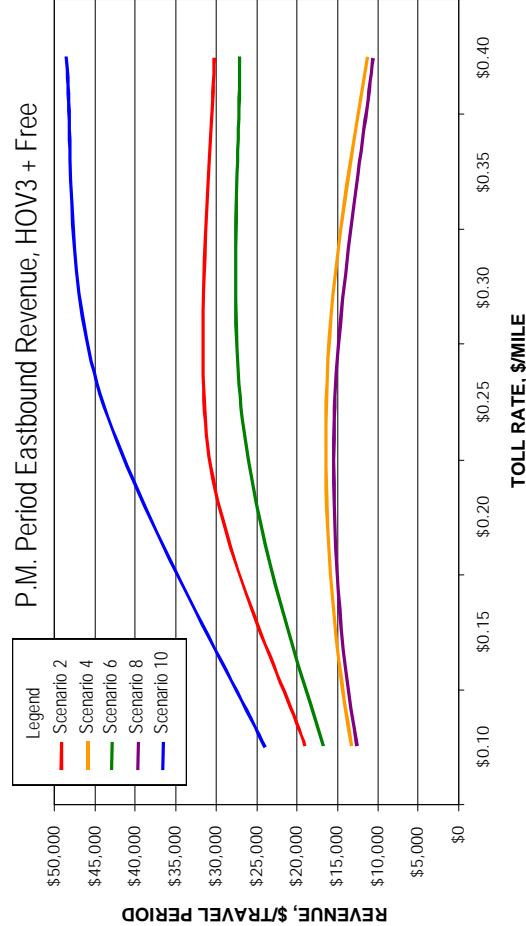
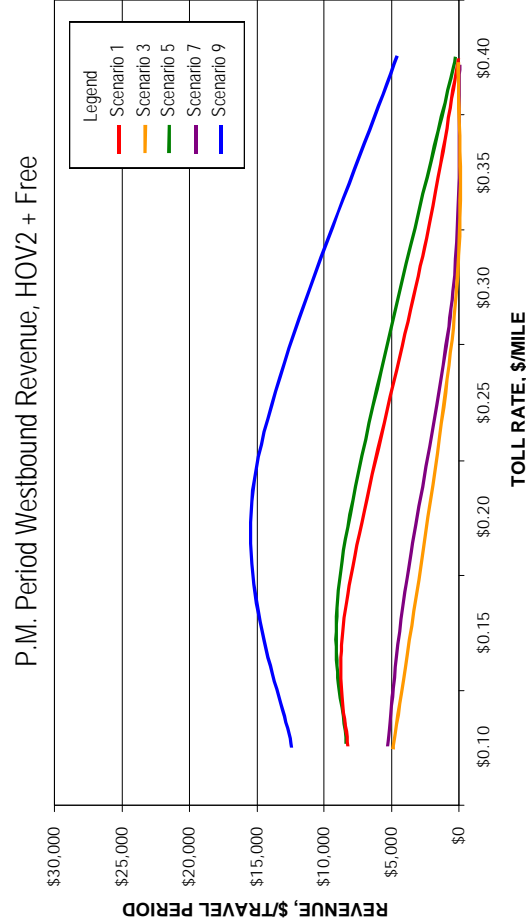
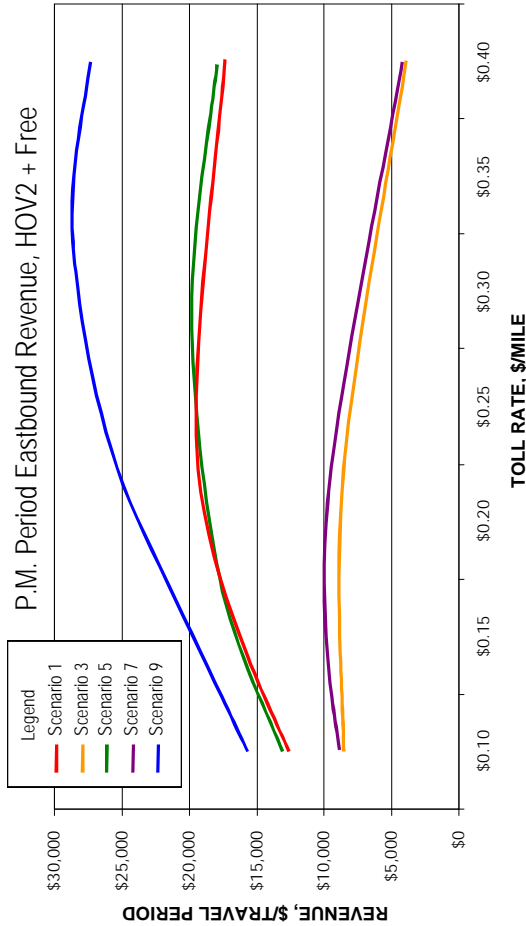


Midday Period Eastbound Revenue, HOV3 + Free



Midday Period Westbound Revenue, HOV3 + Free





TOLL SENSITIVITY CURVES
P.M. Period (3:00 P.M. - 7:00 P.M.)

Table 4-2 presents a convenient summary of optimum toll rates by scenario, period and travel direction used in computing annual revenues for the MLs facility. However, as will be discussed in more detail below, the determination of true “optimum” rates will ultimately be a policy decision which should ultimately take into consideration the need for revenue maximization as well as optimizing the traffic distribution between general purpose and managed lane facilities.

Table 4-2
Summary of Optimum Toll Rates By Scenario

| Scenario | Description | Toll Rates Per Mile (Cents) | | | | | |
|----------|--|-----------------------------|--------|-----------|--------|---------|--------|
| | | A.M. Peak | | P.M. Peak | | Mid-Day | |
| | | EB | WB | EB | WB | EB | WB |
| 1 | Base HOV-2+ Free - 4 Lanes | \$0.15 | \$0.15 | \$0.25 | \$0.15 | \$0.10 | \$0.10 |
| 2 | Base HOV-3+ Free - 4 Lanes | 0.20 | 0.20 | 0.30 | 0.15 | 0.10 | 0.10 |
| 3 | Base HOV-2+ Free - 5 Lanes | 0.15 | 0.10 | 0.15 | 0.10 | 0.10 | 0.10 |
| 4 | Base HOV-3+ Free - 5 Lanes | 0.15 | 0.15 | 0.20 | 0.10 | 0.10 | 0.10 |
| 5 | Reduced Access HOV-2+ Free - 4 Lanes | 0.15 | 0.15 | 0.25 | 0.15 | 0.10 | 0.10 |
| 6 | Reduced Access HOV-3+ Free - 4 Lanes | 0.25 | 0.20 | 0.30 | 0.15 | 0.15 | 0.10 |
| 7 | Reduced Access HOV-2+ Free - 5 Lanes | 0.15 | 0.15 | 0.15 | 0.10 | 0.10 | 0.10 |
| 8 | Reduced Access HOV-3+ Free - 5 Lanes | 0.15 | 0.15 | 0.20 | 0.10 | 0.10 | 0.10 |
| 9 | Base HOV-2+ Free - 4 Lanes (Year 2025) | 0.30 | 0.20 | 0.35 | 0.20 | 0.15 | 0.10 |
| 10 | Base HOV-3+ Free - 4 Lanes (Year 2025) | 0.35 | 0.35 | 0.35 | 0.25 | 0.20 | 0.15 |

TOLL RATE/OPERATIONAL TRADEOFFS

By their very nature, there is a high degree of sensitivity and tradeoff between traffic and revenue and MLs and operating conditions in the outside lanes. In general, as toll rates in the MLs are reduced, the higher share of the total “global demand” on the freeway facility will choose to use the MLs. As the share of that traffic in the MLs increases, operating speeds on the GP lanes can be assumed to improve and congestion decreases. However, as congestion decreases in the GP lanes, the “value” associated with using the MLs trends to decrease, resulting in the delicate

equilibrium between the operating conditions in MLs and the GP lanes and the price associated with the use of the MLs.

A previous section of this report showed toll rates per mile which generally produced close to maximum revenue potential. However, maximum revenue potential typically increases at levels with less than maximum traffic utilization of the MLs. Depending on policy considerations, it may be important to look at toll revenue maximization, utilization rates in the MLs and operational impacts in both the general purpose and MLs in selecting optimum pricing strategies and rate levels. To illustrate this tradeoff, toll rate/operations profiles were developed for the a.m. peak, midday and p.m. peak conditions for Scenarios 1, 2, 9 and 10. Scenarios 1 and 2 reflect the base project configuration and baseline 2015 global demand estimate and differ only in whether or not vehicles with two or more occupants are required to pay tolls. HOV-3 traffic is toll-free in both cases.

Scenarios 9 and 10 reflect the same two operating conditions; but reflect a case of 15 percent higher global demand, which might be indicative of a future-year condition, such as 2025. By reviewing these toll rate/operations profiles, it is easy to see the impact that small changes in demand and pricing strategies can have on achieving policy objectives of the ML project on the LBJ Freeway.

Figures 4-4 through 4-7 provide the comparative operations profile for the a.m. peak period, for Scenarios 1, 2, 9 and 10.

Each page portrays the scenario in question by showing:

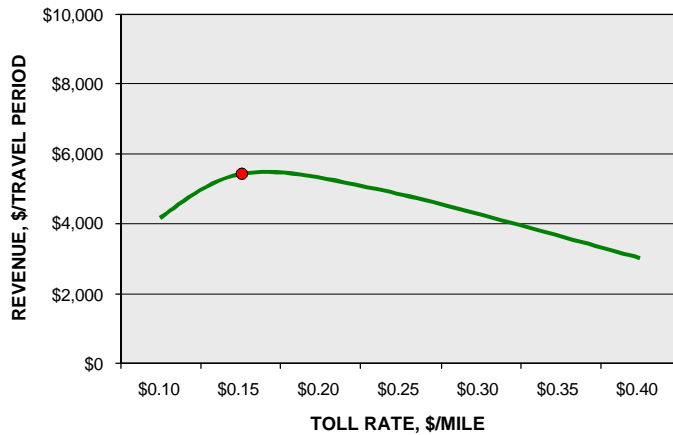
- ✍ The revenue collected vs. toll rate,
- ✍ The VMT by class of vehicle vs. toll rate, and
- ✍ The speed in the MLs and GP lanes vs. toll rate.

This is further desegregated so that the data for all of this information is presented for the:

- ✍ Eastbound direction in one series of three charts, and
- ✍ For the westbound direction for another series of charts.

In Figure 4-4, the data for Scenario 1 in the AM period is presented by direction. The toll rate which generates the maximum revenue for that scenario and time period is shown by a red dot. In Scenario 1 for the AM period in the eastbound direction, that toll rate is shown as \$0.15 per mile, which generates approximately \$5,500 during that period for a typical

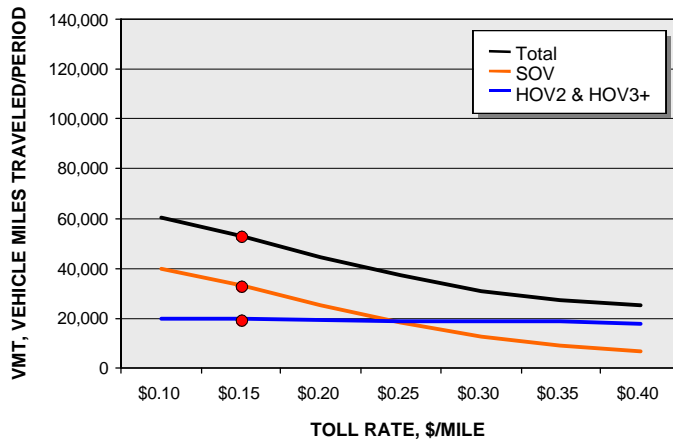
EASTBOUND REVENUE



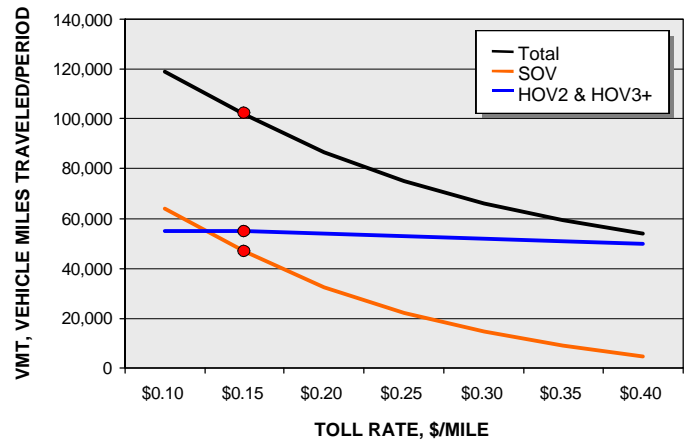
WESTBOUND REVENUE



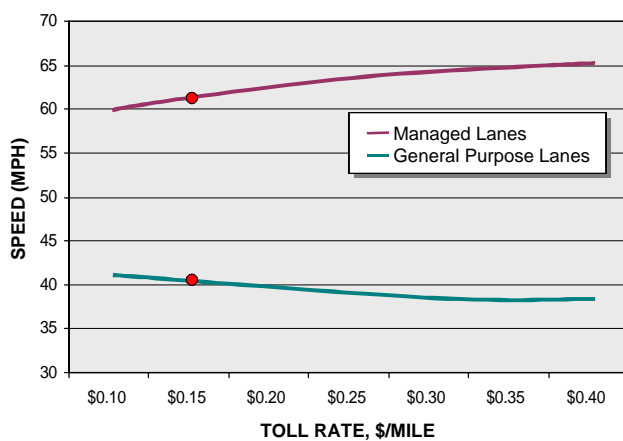
EASTBOUND VMT ON MANAGED LANES



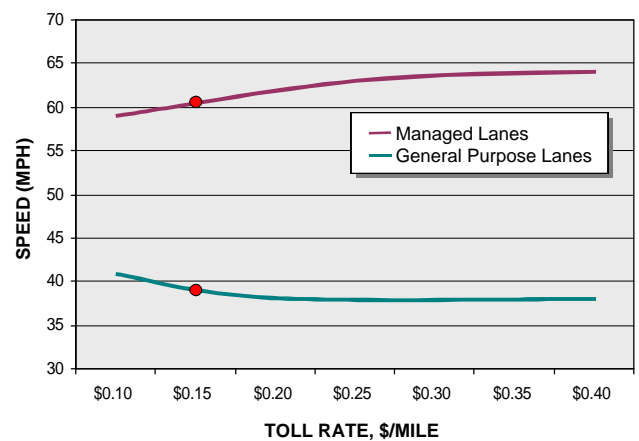
WESTBOUND VMT ON MANAGED LANES



EASTBOUND SPEED



WESTBOUND SPEED



• - Optimum Toll Rate



Wilbur Smith Associates

TOLL RATE / OPERATIONS PROFILE
A.M. Weekday Peak Period (6:00A.M. – 9:00A.M.)
 Scenario 1 Year 2015 – HOV2+ Free

FIGURE 4-4

weekday as opposed to a weekend. In the westbound direction, the revenue is significantly higher, i.e., approximately \$8,500, but drops off at a far more rapid rate as the tolls rise.

In the second pairing of charts in Figure 4-4, the vehicle miles of travel (VMT) by direction are shown:

- ✍ For total vehicles,
- ✍ For toll vehicles (in this Scenario SOV only), and
- ✍ For all classes of HOVs (toll free) on the MLs.

Again, the performance in the westbound direction substantially exceeds that of the eastbound direction for each class of vehicle in the AM period.

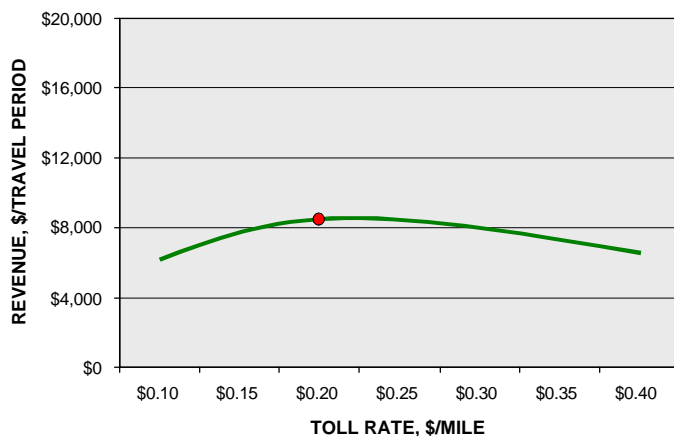
In general, the volume of HOV-2 and HOV-3+ vehicles remains relatively constant regardless of toll rates. This is because these vehicles are assumed to be toll-free in Scenario 1 and are not significantly influenced by toll rate changes. However, the traffic volume, as represented in these figures by VMT, of toll-paying SOV traffic declined significantly as toll rates increase.

The lower portion of Figure 4-4 shows overall average speeds from the traffic assignment results in the GP lane and MLs facilities with respect to different toll rate assumptions for SOV traffic only in the managed lane. The average speeds were determined by taking total VMT assigned to the GP and MLs and dividing this by total vehicle hours of travel; hence, the average speeds reflect overall averages over the entire length of the portion of the LBJ Freeway analyzed in this study.

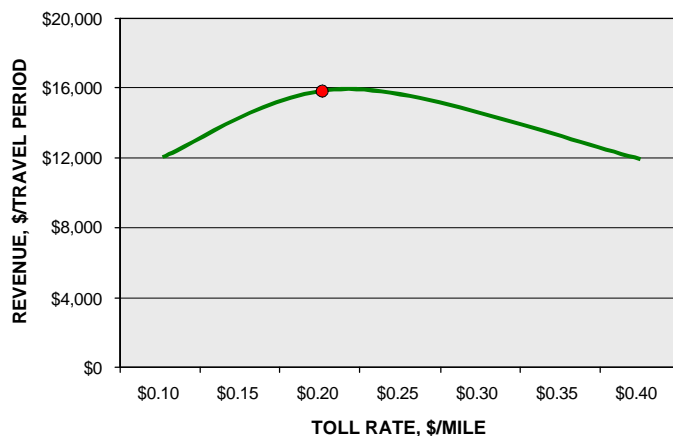
As might be expected, there is a significant difference in computed overall average speeds between the GP lanes and MLs. As toll rates increase, average speeds in the MLs are shown to increase slightly as some of the single-occupant vehicle traffic is shifted back to the GP lanes. As a result of this, average operating speeds in the GP lanes decrease slightly as toll rates increase in the MLs.

In Figure 4-5 the performance characteristics for Scenario 2 are presented by direction for the AM period. Under this scenario, HOV-2s are tolled along with SOVs. Total revenue is seen to again be twice as high in the westbound direction as the eastbound. A significant distinction in this series of charts is that the revenue levels for both directions are almost double the corresponding levels for Scenario 1. This is the obvious result of tolling SOV-2s in this scenario as opposed to not tolling them in Scenario 1.

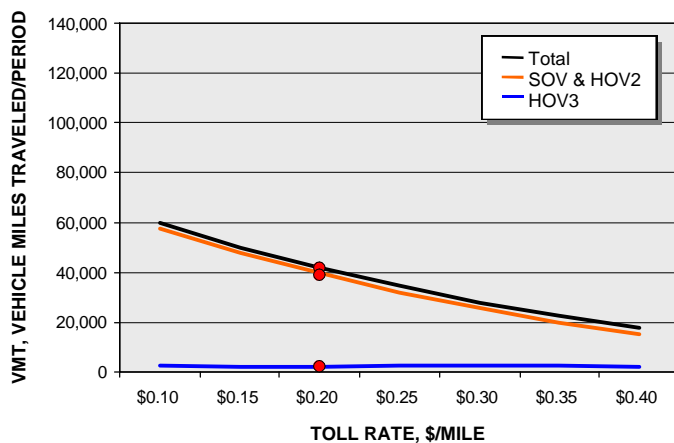
EASTBOUND REVENUE



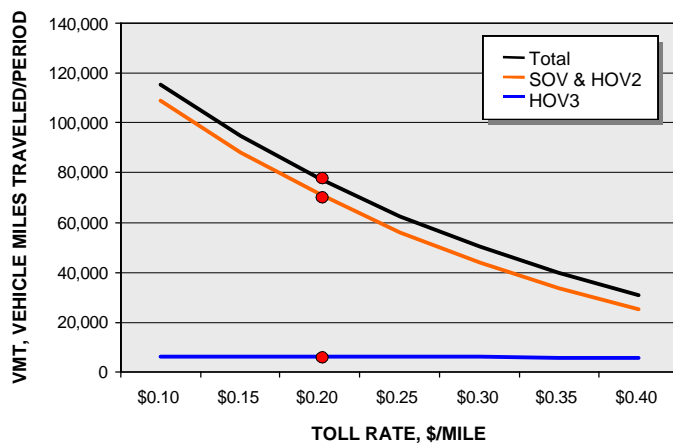
WESTBOUND REVENUE



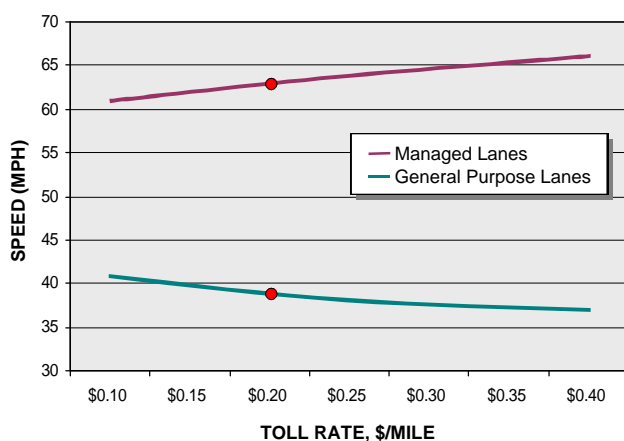
EASTBOUND VMT ON MANAGED LANES



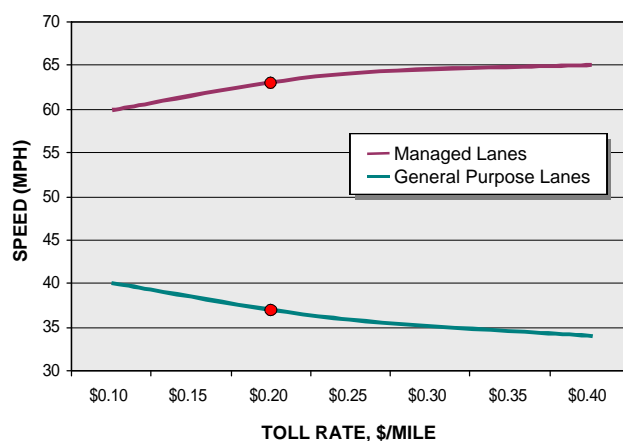
WESTBOUND VMT ON MANAGED LANES



EASTBOUND SPEED



WESTBOUND SPEED



• - Optimum Toll Rate



Wilbur Smith Associates

TOLL RATE / OPERATIONS PROFILE
A.M. Weekday Peak Period (6:00A.M. – 9:00A.M.)
Scenario 2 Year 2015 – Base HOV3+ Free

FIGURE 4-5

The drop-off in revenues as toll rates raise is less severe in this scenario for this period than the drop-off for Scenario 1 in the corresponding period.

The VMT as compared to toll rate is shown for Scenario 2 by class of vehicle on the ML facility. Westbound VMT by class of vehicle is far higher than eastbound VMT. However, the distribution of VMT is shown to be dramatically different by class of vehicle as compared to Scenario 1.

In Scenario 1, the curves representing Total VMT and the VMT for SOVs and HOVs were separated by a considerable margin, i.e., approximately 20-50,000 miles traveled per AM period. Both curves drop off gradually as toll rates rise, which is, as one would expect. In Scenario 1, the composition of VMT for HOV-2 & 3+ is relatively flat across all toll rates, because they are riding free at all levels of tolling.

In Scenario 2, however, the VMT curves differ substantially; because HOV-2s are now tolled and only HOV-3+ ride free. HOV-3+ comprises such a small percentage of the total traffic that the VMT in the MLs is substantially that of the SOVs and HOV-2s. This is seen clearly by the fact that the SOV/HOV-2 curve is almost sitting directly over the curve for Total VMT in the MLs. VMT for HOV-3+s in the MLs is almost zero, meaning that only the those SOVs and HOV-2s that wish to pay a toll are in the ML and the free riding and almost non-existent HOV-3s are there in extremely small numbers.

The speeds are, as one would expect for Scenario 2 as compared to 1 in that the speed in the GP lanes is substantially lower for Scenario 2, because many of the HOV-2s are driven into the GP lanes by the imposition of a toll in this scenario.

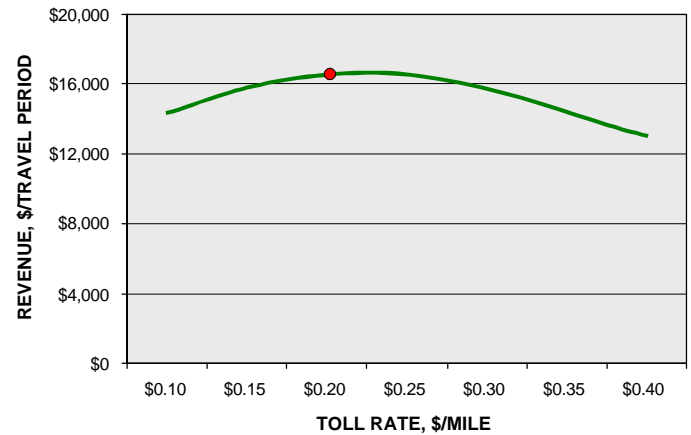
The performance charts for the AM period for Scenario 9 are presented next, see Figure 4-6. As noted earlier, the revenue level for the Scenario 9 is substantially higher than for Scenario 1, however the shape of the curves, the distribution of VMT by class are broadly parallel.

The major distinction is in the directional speeds, i.e., they are substantially different than the corresponding performance measure for Scenario 1, as one might expect. The very concept of MLs is that as traffic grows, the toll rates rise to keep the traffic flowing in the MLs. Therefore, as the traffic builds in 2025 vs. 2015, the growth in traffic is mainly carried by the GP lanes, slowing traffic there considerably so that a free flowing corridor remains for the region as new platform for mobility into

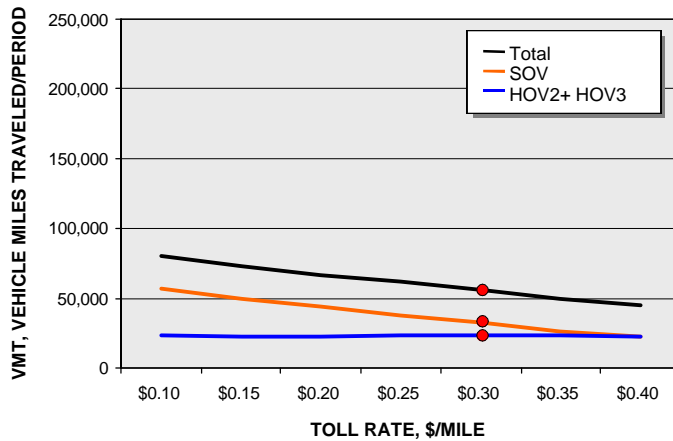
EASTBOUND REVENUE



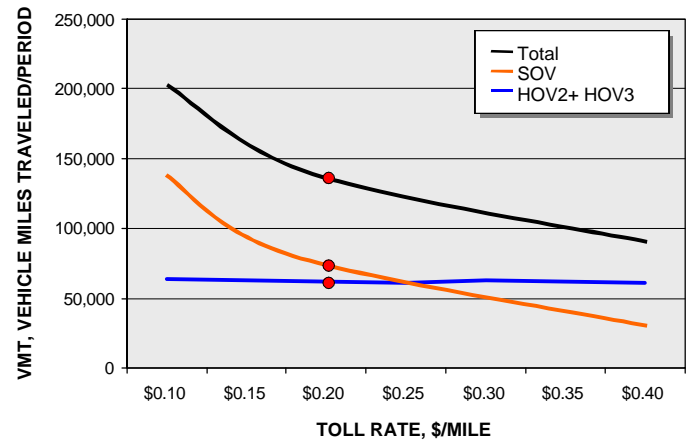
WESTBOUND REVENUE



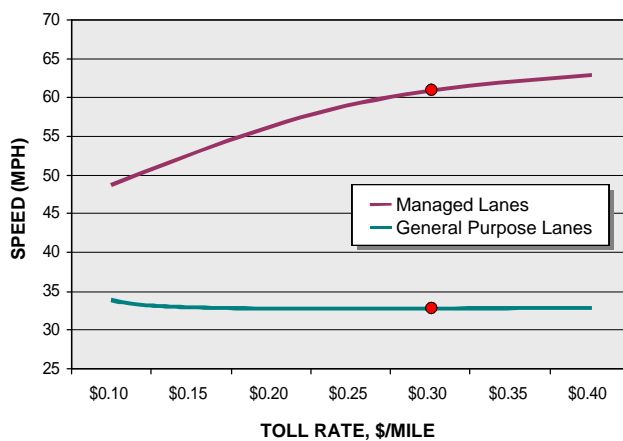
EASTBOUND VMT ON MANAGED LANES



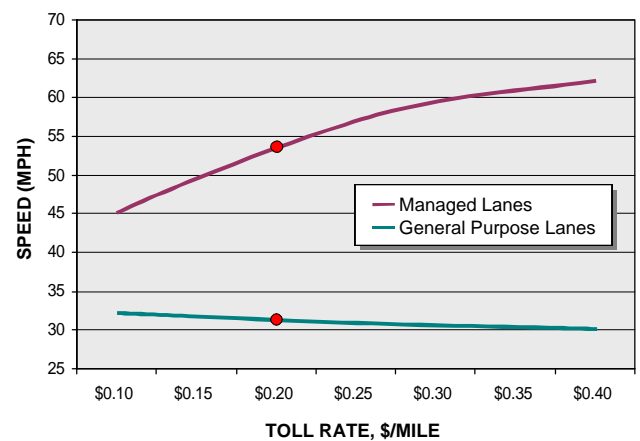
WESTBOUND VMT ON MANAGED LANES



EASTBOUND SPEED



WESTBOUND SPEED



• - Optimum Toll Rate

the future. The ML speeds are still shown to be in the range of 55 to 60 MPH while the GP lane speed is seen to be falling below 35 MPH.

The operational characteristics for Scenario 10 are shown in Figure 4-7. They are very structurally similar to the curves seen in Figure 4-5, which represents Scenario 2. However they differ significantly in scale.

The revenues are almost double. One can see the same near overlap of VMT relative to SOVs and HOV-2s and Total VMT, except that the levels are about 25 percent higher. And HOV-3+ VMT on the ML falls to near zero levels. Another major shift is seen in the speeds experienced on the ML and the GP lanes in that the GP lane speed is now seen to be near or below 30 mph while the ML speed is still in the 60 mph range.

The revenue levels are unsurprisingly the highest of all the scenarios.

Similar data as that just presented is shown for the remaining two time periods, i.e., midday and P.M. for Scenarios 1, 2, 9, and 10, in Figures 4-8 through 4-15. The assessment of this data roughly follows the outlines of the assessment just presented, so a detailed description will not be repeated.

However, this format clearly shows the comparative performance of the scenarios in a manner that most readily communicates the results of shifts in policies before actually implementing a particular policy proposal. While there are several ways of examining each set of charts, it seems that this facility has a number of ways to successfully be operated depending on the policy goals that the region chooses to pursue.

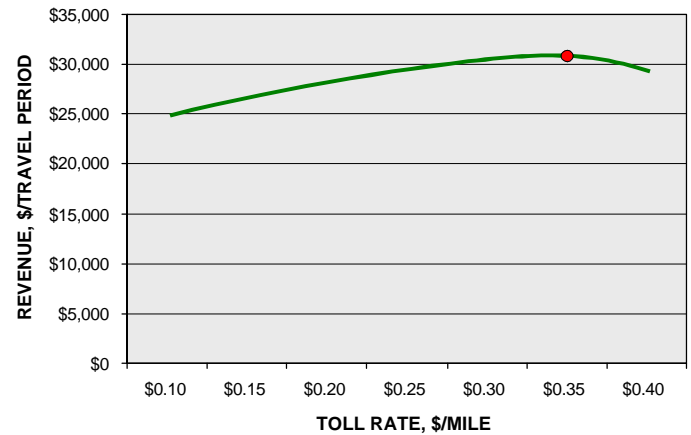
The performance of Scenario 10 clearly shows some very interesting opportunities for further evaluation and consideration. With travel speeds in excess of 60 mph in the MLs, there is clearly capacity for added HOV and/or BRT accommodation.

The problem is that there are very few HOV-3+ or BRT vehicles in the region that might be accommodated on this facility. Given existing spatial development patterns, there will be great difficulty in increasing those numbers. Even with some of the aggressive and interesting innovative marketing and pricing strategies discussed in other sections of this report, increasing HOV-3+ and BRT users will face the significant hurdles that have dogged shared ride systems in the auto-based development climate that characterizes the United States in the late 20th and early 21st centuries.

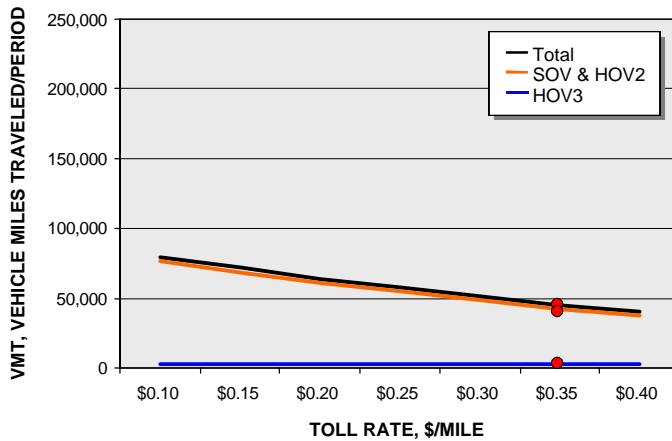
EASTBOUND REVENUE



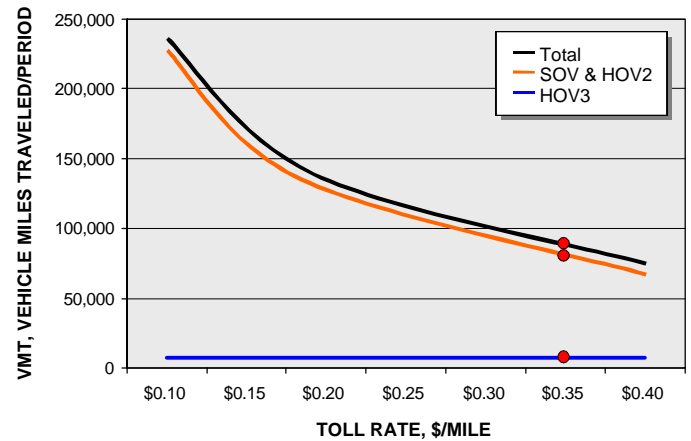
WESTBOUND REVENUE



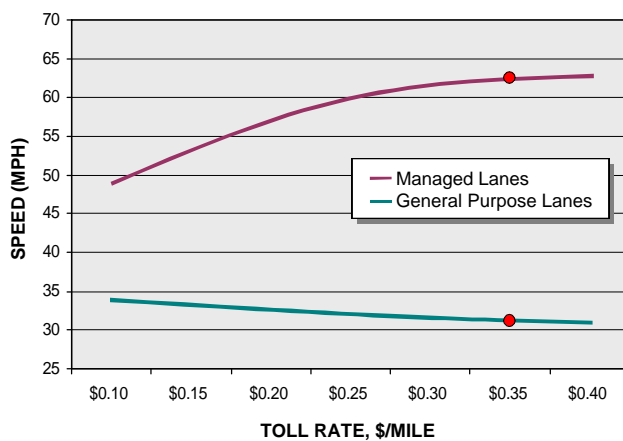
EASTBOUND VMT ON MANAGED LANES



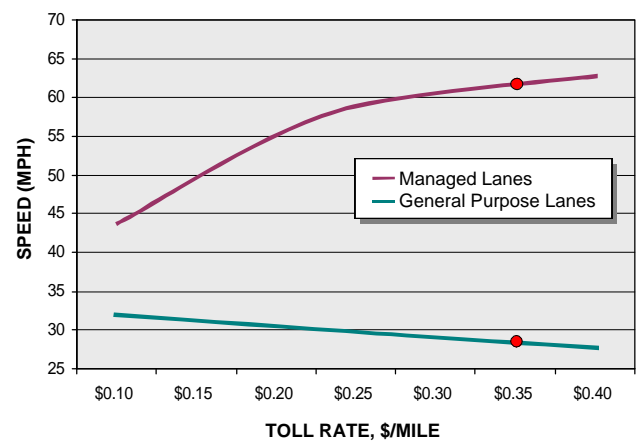
WESTBOUND VMT ON MANAGED LANES



EASTBOUND SPEED

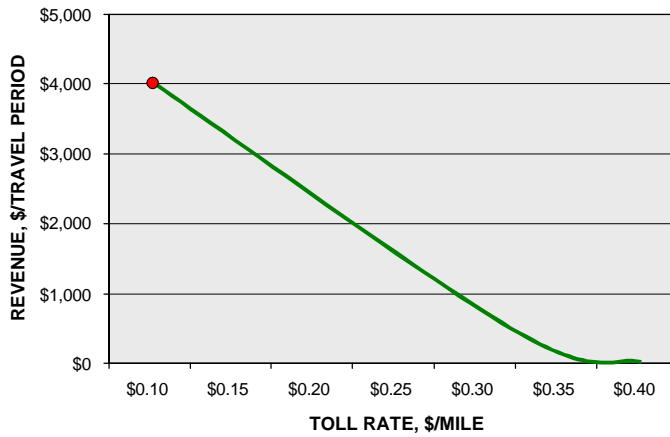


WESTBOUND SPEED

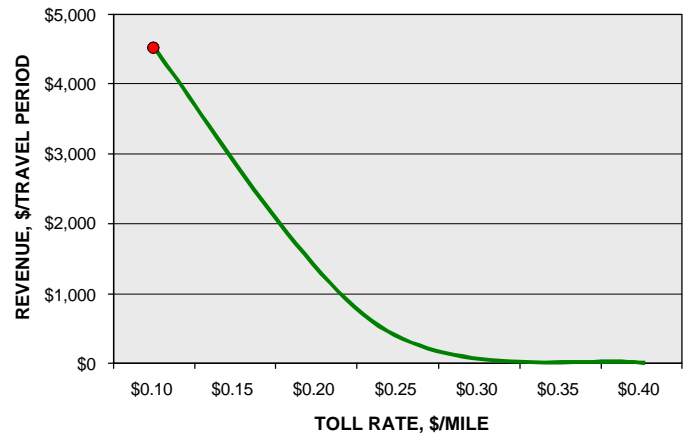


● - Optimum Toll Rate

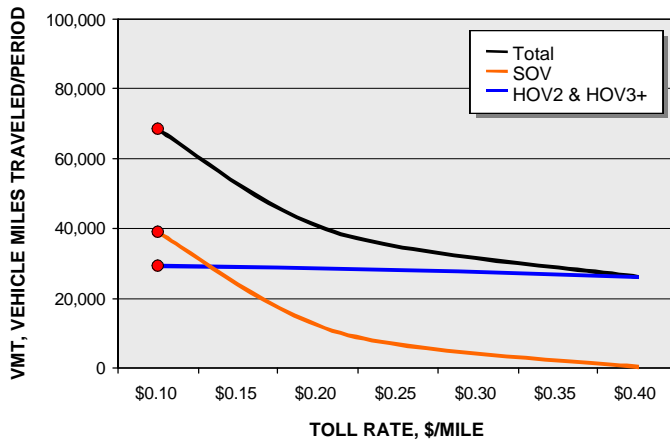
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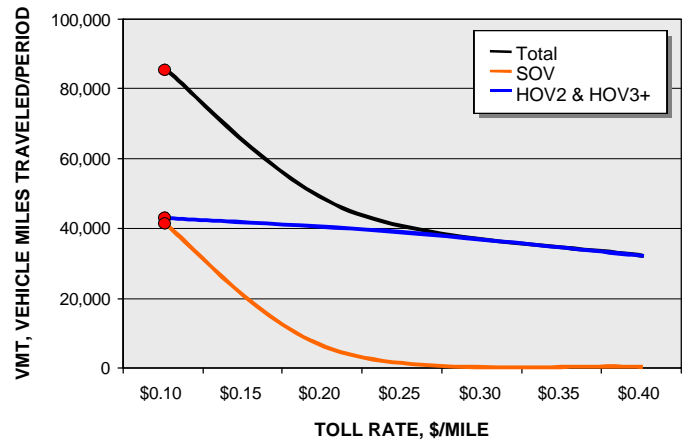
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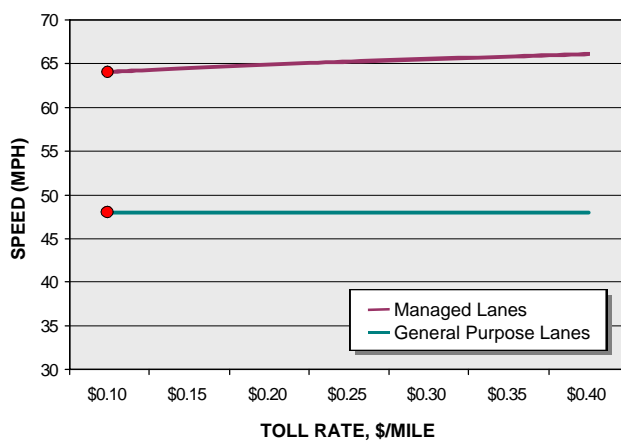
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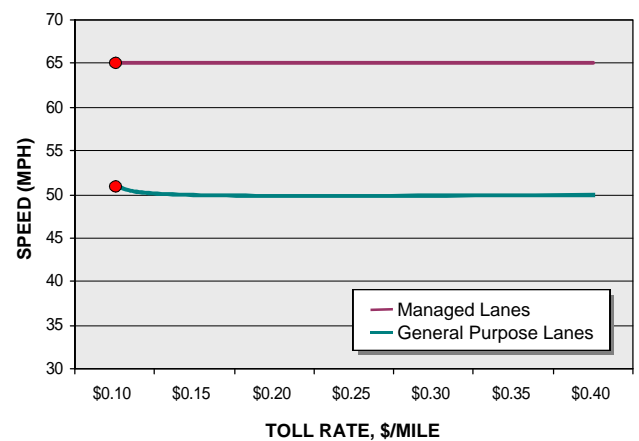
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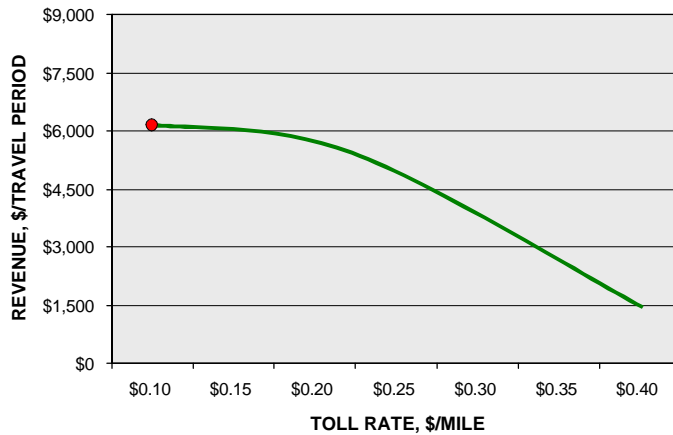


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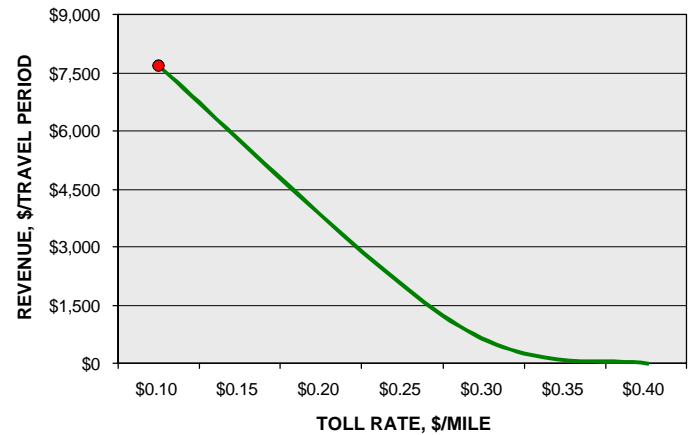


• - Optimum Toll Rate

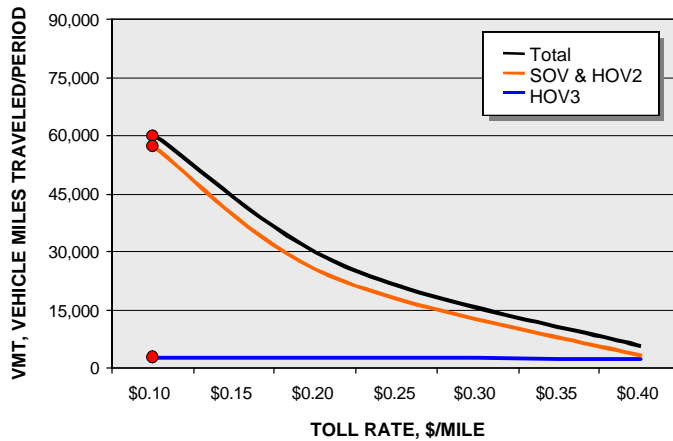
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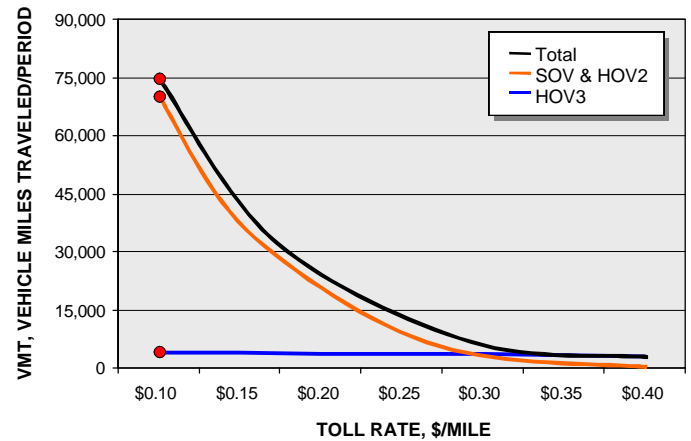
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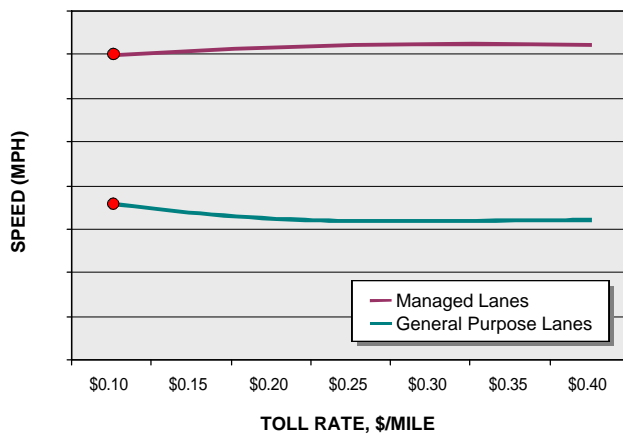
EASTBOUND VMT ON MANAGED LANES



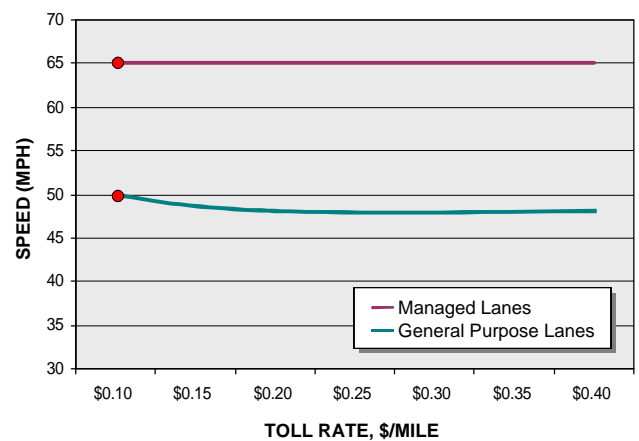
WESTBOUND VMT ON MANAGED LANES



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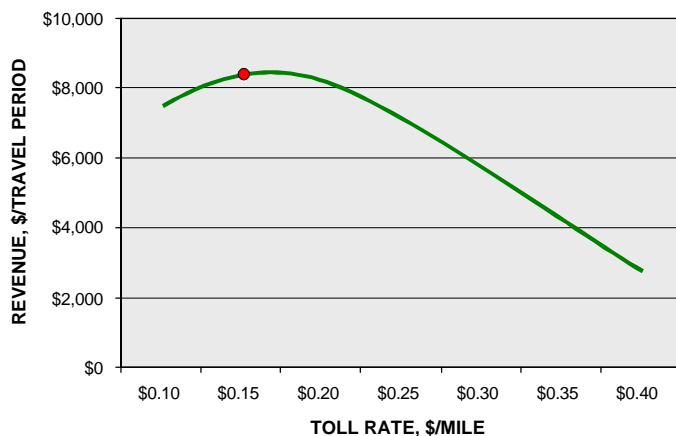


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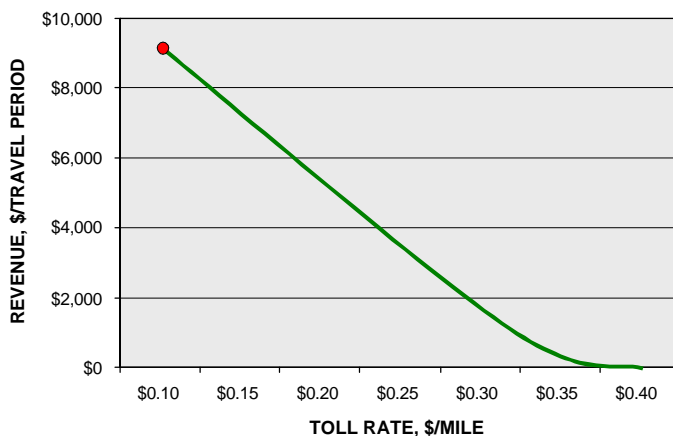


• - Optimum Toll Rate

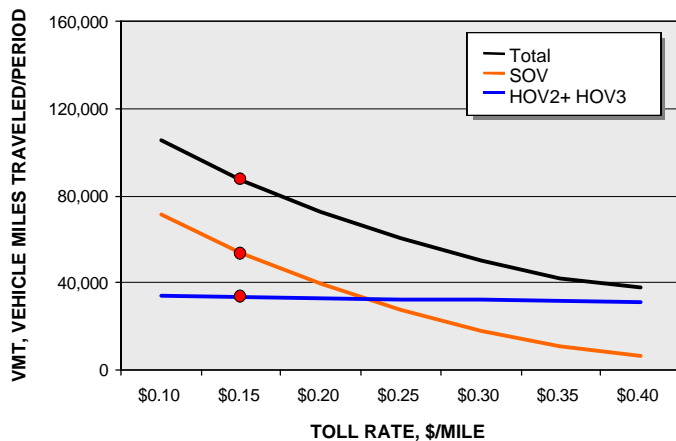
EASTBOUND REVENUE



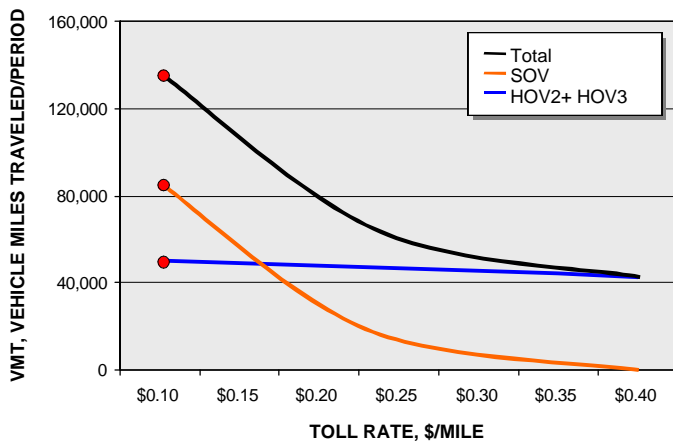
WESTBOUND REVENUE



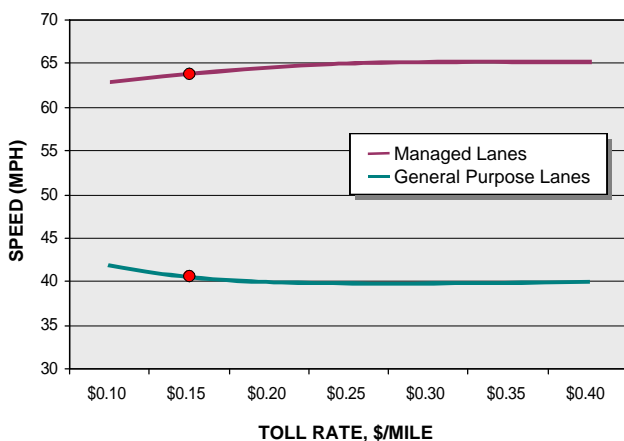
EASTBOUND VMT ON MANAGED LANES



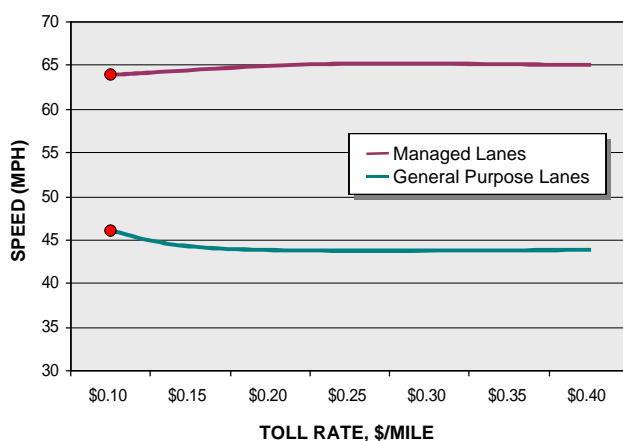
WESTBOUND VMT ON MANAGED LANES



EASTBOUND SPEED

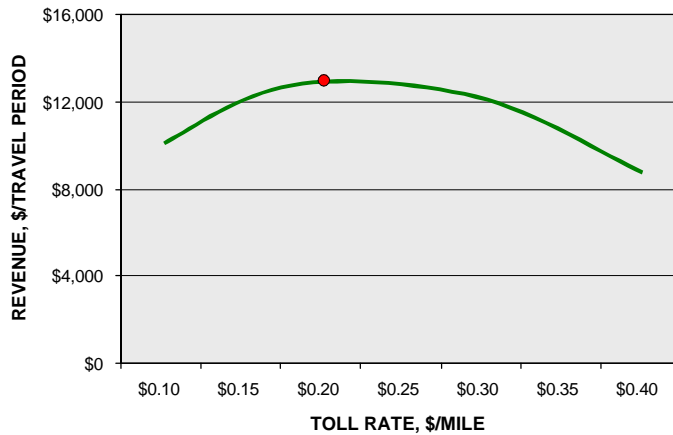


WESTBOUND SPEED



● - Optimum Toll Rate

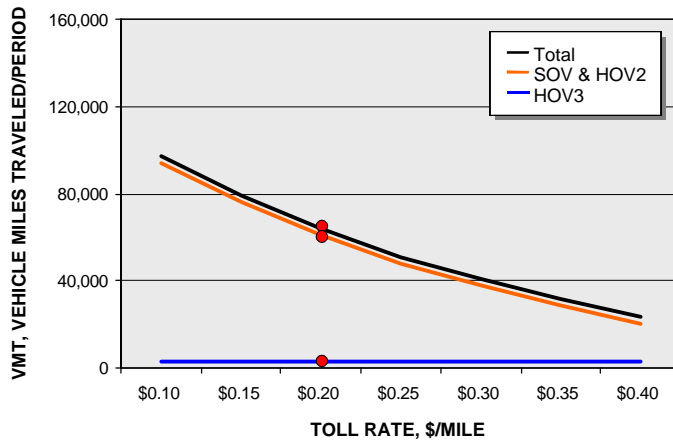
EASTBOUND REVENUE



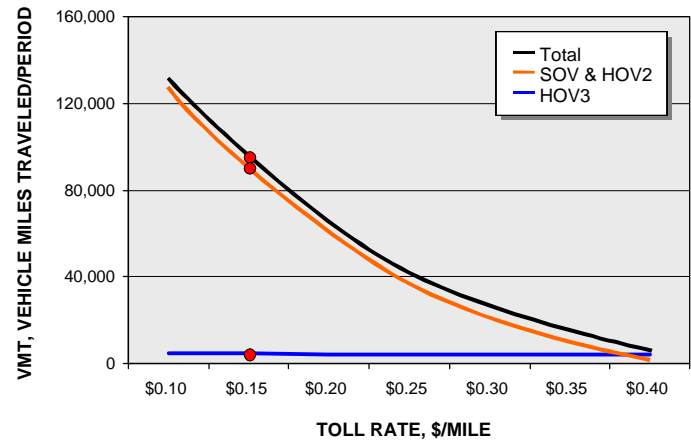
WESTBOUND REVENUE



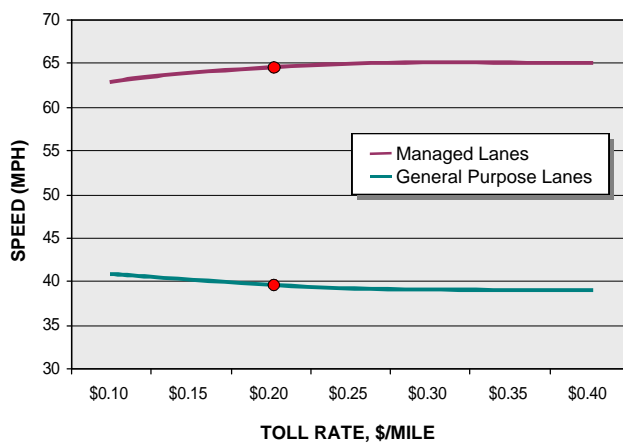
EASTBOUND VMT ON MANAGED LANES



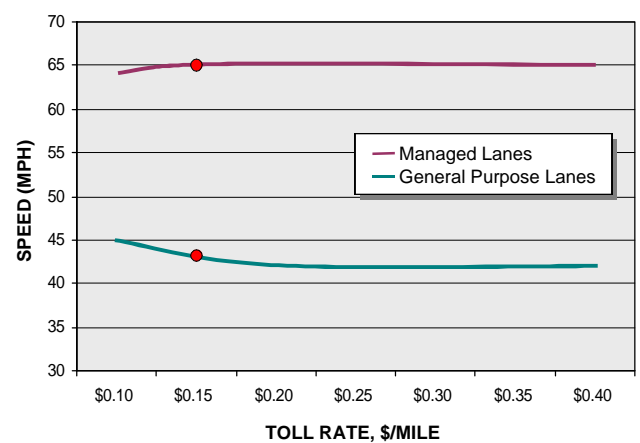
WESTBOUND VMT ON MANAGED LANES



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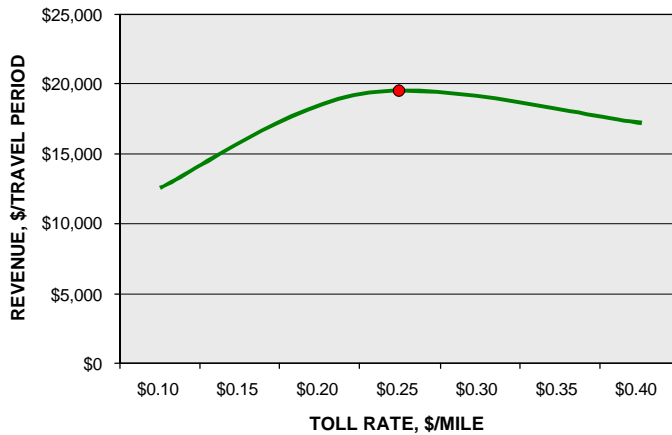


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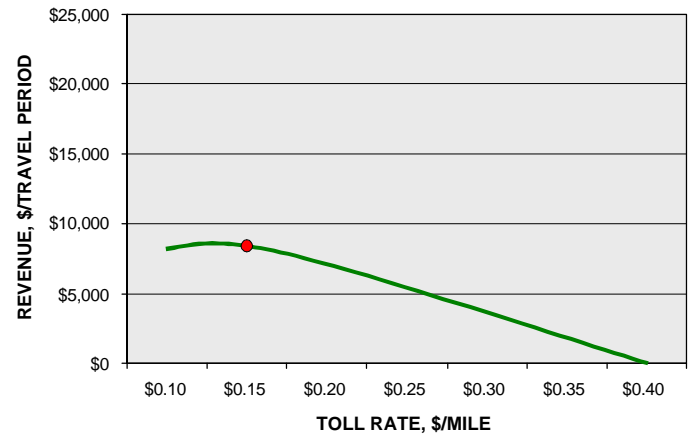


• - Optimum Toll Rate

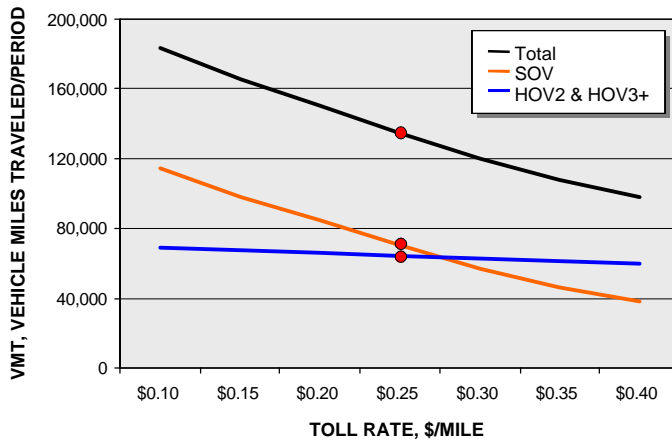
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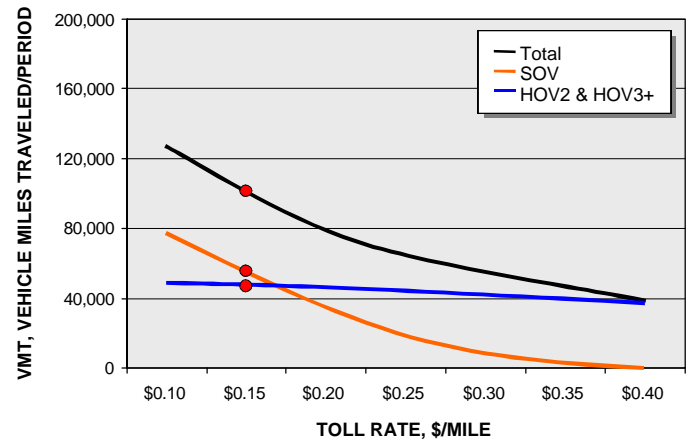
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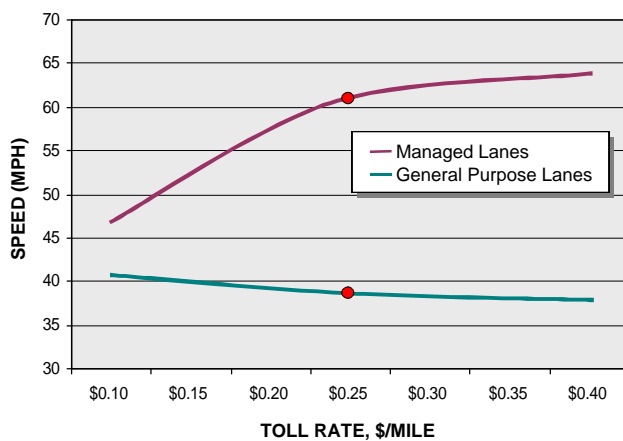
EASTBOUND VMT ON MANAGED LANES



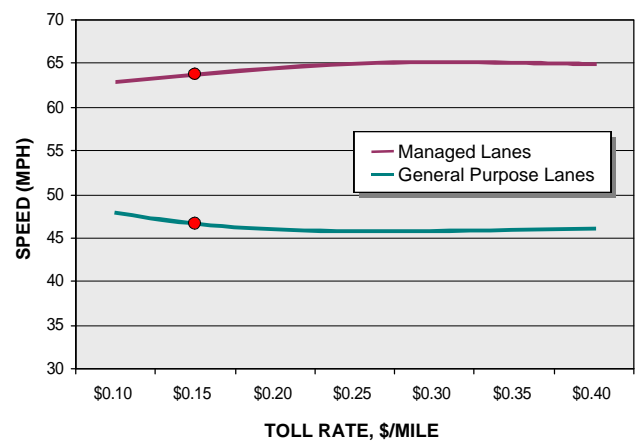
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EASTBOUND SPEED



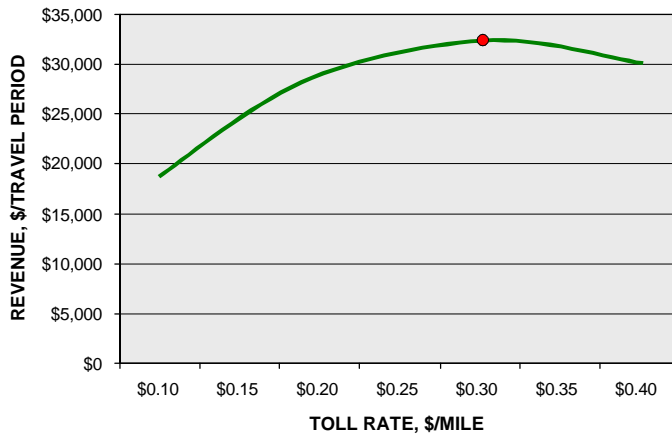
WESTBOUND SPEED



• - Optimum Toll Rate

LBJ Freeway Managed Lanes Study

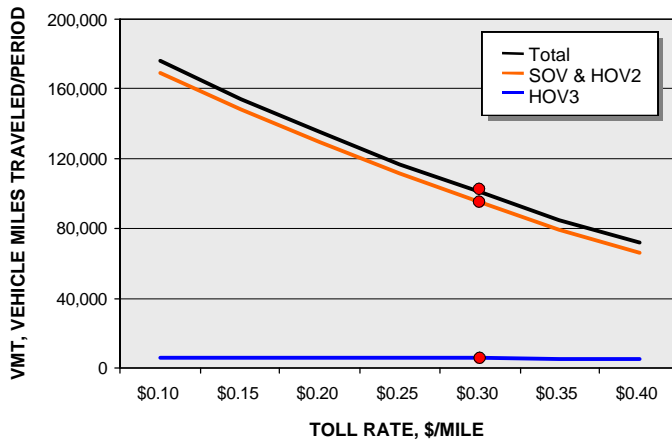
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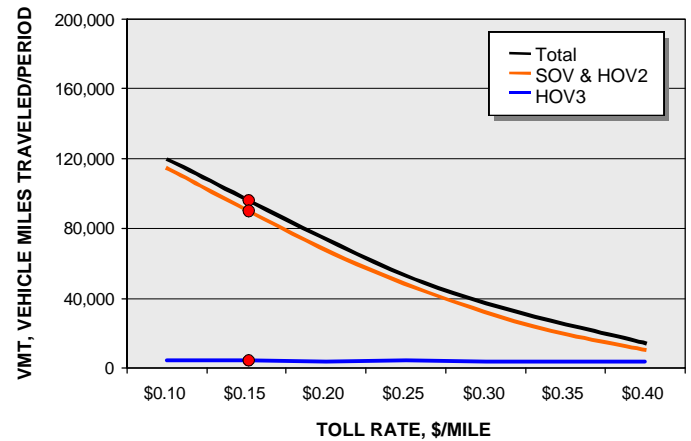
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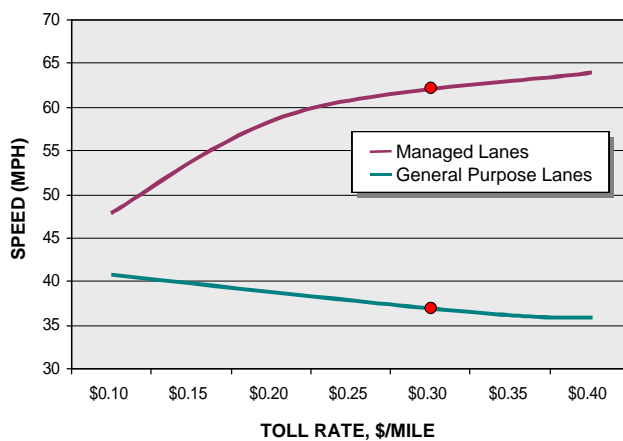
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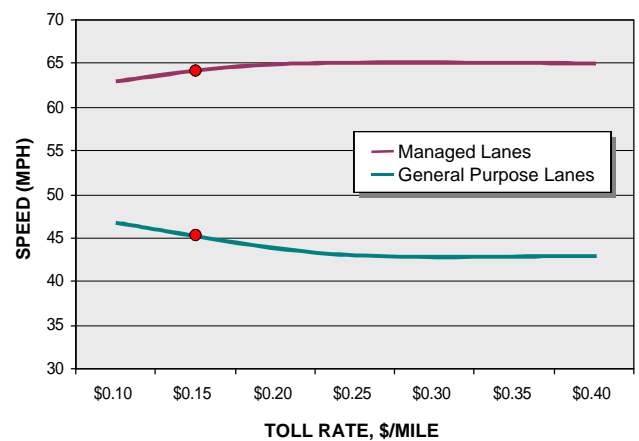
WESTBOUND VMT ON MANAGED LANES



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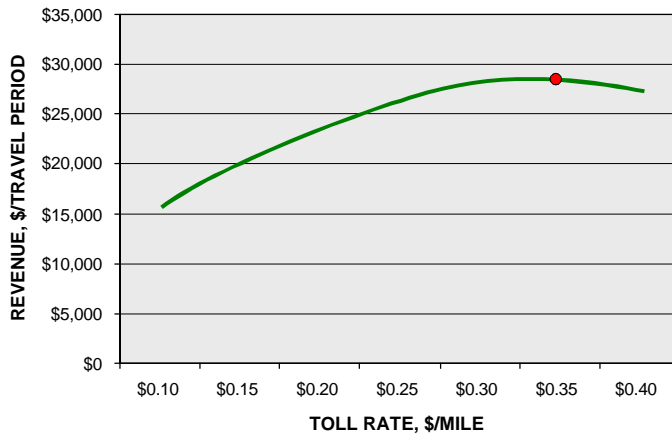


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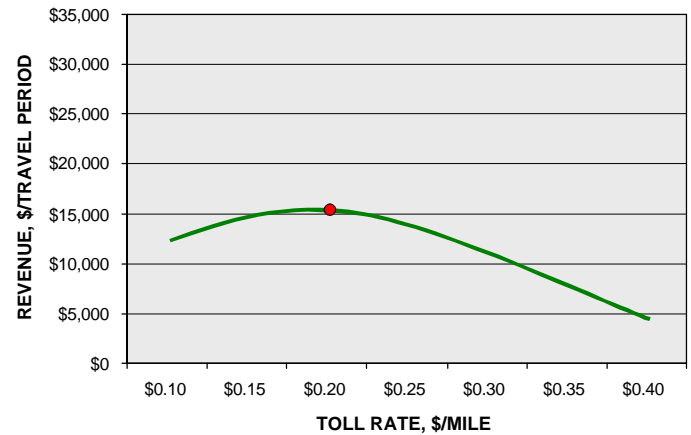


● - Optimum Toll Rate

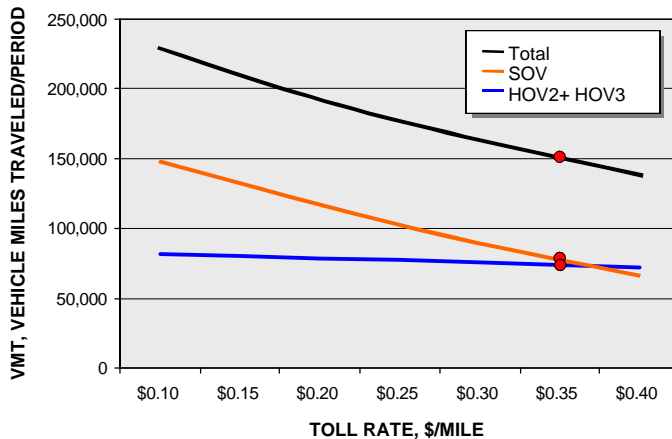
EASTBOUND REVENUE



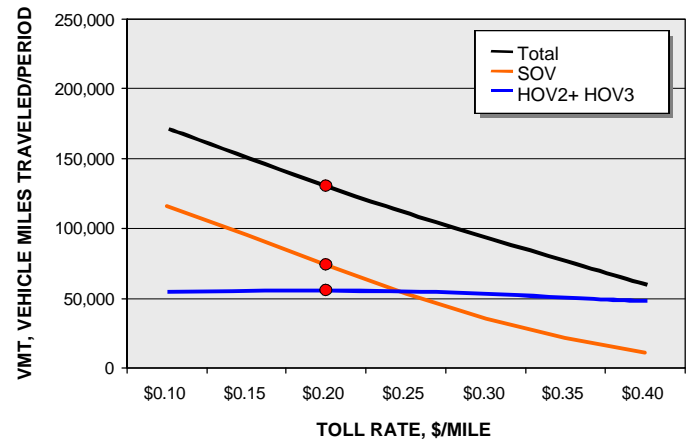
WESTBOUND REVENUE



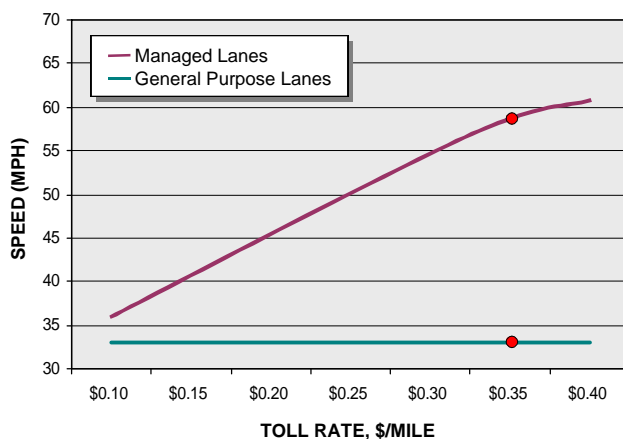
EASTBOUND VMT ON MANAGED LANES



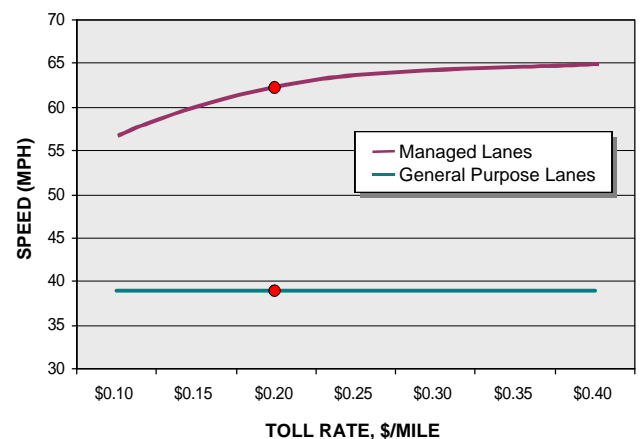
WESTBOUND VMT ON MANAGED LANES



EASTBOUND SPEED

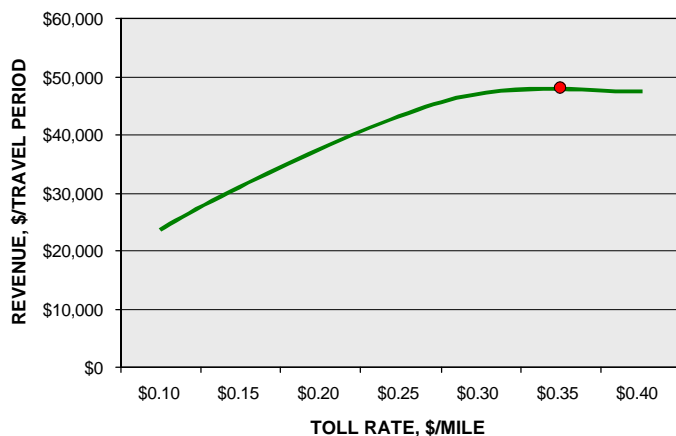


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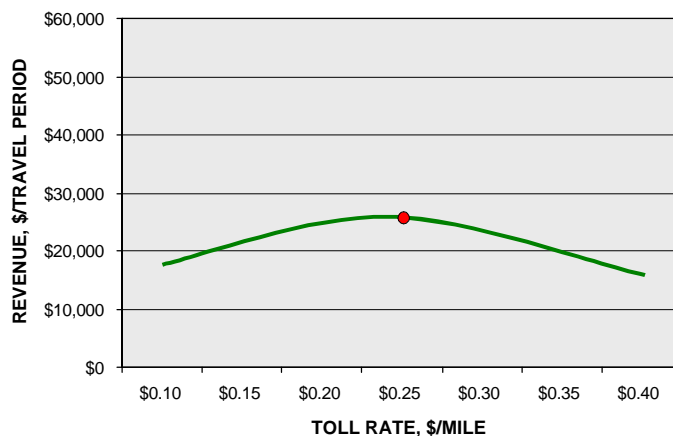


● - Optimum Toll Rate

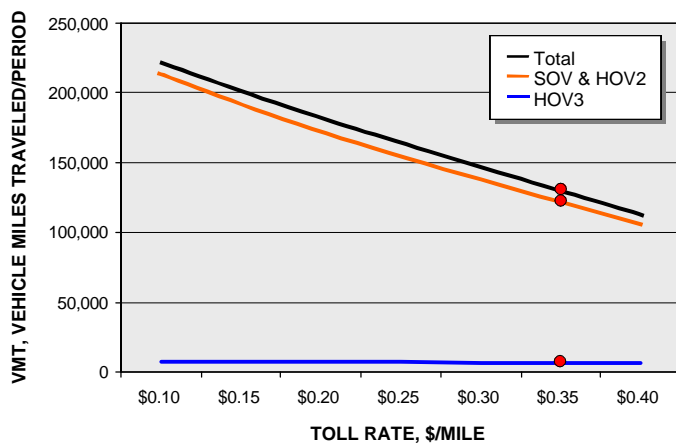
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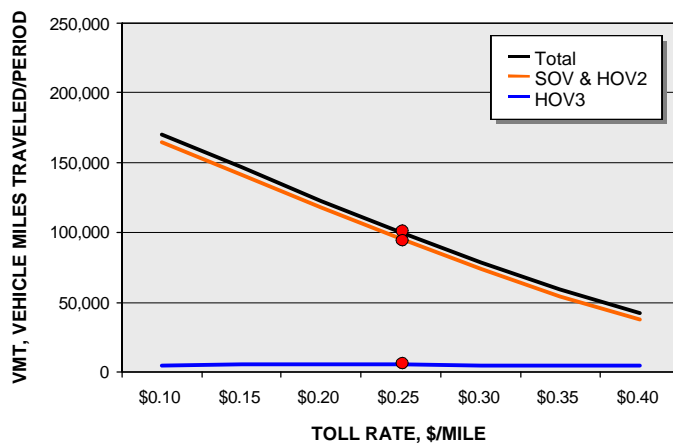
WESTBOUND REVENUE



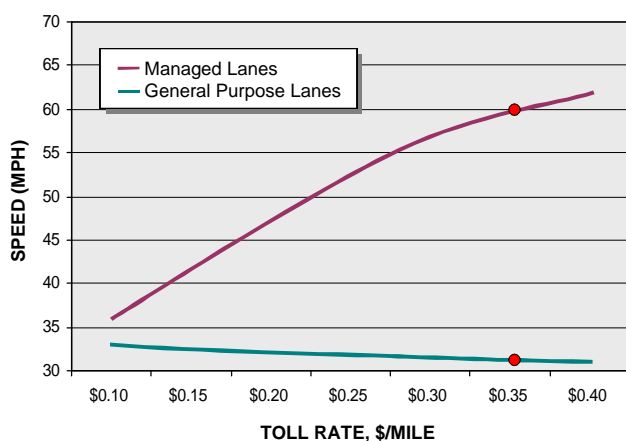
EASTBOUND VMT ON MANAGED LANES



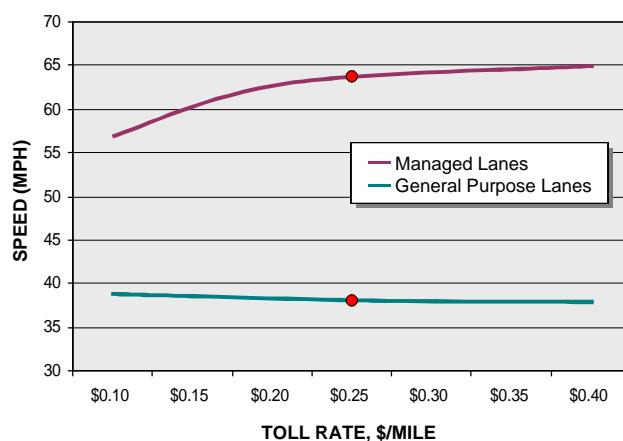
WESTBOUND VMT ON MANAGED LANES



EASTBOUND SPEED



WESTBOUND SPEED



● - Optimum Toll Rate

Table 4-3 presents estimated toll revenue by period and scenario. Weekday revenue by travel direction was output from the micro-model for each alternative toll rate. Revenues shown in Table 4-3 for each period were obtained at the “optimum” toll levels described previously, for each direction, and then aggregated to each daily period. For example, under Scenario 1, approximately \$51,000 in daily revenue would be expected on a typical weekday, during the evaluation period covered by the analysis. This excluded the nighttime hours that are between 7:00 p.m. and 6:00 a.m. The nighttime hours were not specifically evaluated in this study, however actual experience on other MLs facilities such as S.R. 91 shows that 2 to 4 percent of total revenue is typically collected during the overnight hours. Therefore, for purposes of this analysis nighttime revenue is approximated at 3 percent of the total computed weekday revenue for the hours between 6:00 a.m. and 7:00 p.m. In the case of Scenario 1, this would add approximately \$1,535 in additional revenue, producing total weekday revenue of \$52,710.

The study also did not specifically evaluate weekend conditions. While traffic levels can sometimes be quite high on weekends, hourly traffic variations are generally significantly different than weekdays, resulting in both different utilization patterns and different pricing patterns for the MLs facility. Again, weekend day revenue was approximated at 50 percent of weekday revenue, generally based on comparable experience on the S.R. 91 MLs facility. While S.R. 91 is more of a radial facility and the LBJ is essentially a portion of a circumferential facility, for this level of analysis it is still felt that a 50 percent reduction in daily traffic levels and revenues should be applied. The nature of capacity utilization on the LBJML is such that a small fall off in volumes in the LBJ corridor will result in a substantial reduction in the ML volumes/revenues just a small increase in volumes results in a disproportionate increase in volumes/revenues on the MLs. A fuller investigation of these phenomena will be undertaken in subsequent studies as the project managers move the projector forward toward investment-grade analyses.

Finally, estimated annual toll revenue for each scenario was computed based on an assumed 250 weekdays per year and 115 weekends/holidays per year. Weekends and holidays were assumed to produce revenue equivalent to 50 percent of the estimated weekday level.

As shown in Table 4-3, annual toll revenue for the different scenarios would range from about \$8.5 million for Scenario 3 to as much as \$47.6 million for Scenario 10. In general, those scenarios, which allow toll-free travel on the MLs to vehicles with two or more occupants, have significantly lower revenue potential than those scenarios, which restrict

Table 4-3
Directional Toll Maximum

| Scenario | Description | Weekday Revenue by Period | | | | Night Revenue (1) | Total Weekday | Weekend Day (2) | Estimated Annual Revenue (3) |
|----------|----------------------------------|---------------------------|----------|----------|-----------|----------------------|------------------|--------------------|---------------------------------|
| | | AM Peak | Midday | PM Peak | Total | | | | |
| 1 | Base HOV2+ - 4 Lanes | \$14,102 | \$8,578 | \$28,495 | \$51,175 | \$1,535 | \$52,710 | \$26,355 | \$16,208,000 |
| 2 | Base HOV3+ - 4 Lanes | \$24,581 | \$13,807 | \$47,353 | \$85,741 | \$2,572 | \$88,313 | \$44,157 | \$27,156,000 |
| 3 | Base HOV2+ - 5 Lanes | \$8,850 | \$3,757 | \$14,174 | \$26,781 | \$803 | \$27,584 | \$13,792 | \$8,482,000 |
| 4 | Base HOV3+ - 5 Lanes | \$18,083 | \$7,252 | \$25,528 | \$50,863 | \$1,526 | \$52,389 | \$26,194 | \$16,110,000 |
| 5 | Reduced HOV2+ - 4 Lanes | \$15,036 | \$8,650 | \$28,949 | \$52,635 | \$1,579 | \$54,214 | \$27,107 | \$16,671,000 |
| 6 | Reduced HOV3+ - 4 Lanes | \$22,119 | \$12,820 | \$41,124 | \$76,063 | \$2,282 | \$78,345 | \$39,172 | \$24,091,000 |
| 7 | Reduced HOV2+ - 5 Lanes | \$10,675 | \$3,689 | \$15,311 | \$29,675 | \$890 | \$30,565 | \$15,283 | \$9,390,000 |
| 8 | Reduced HOV3+ - 5 Lanes | \$17,144 | \$6,695 | \$24,138 | \$47,977 | \$1,439 | \$49,416 | \$24,708 | \$15,196,000 |
| 9 | Base HOV2+ - 4 Lanes(15% growth) | \$25,966 | \$17,546 | \$44,503 | \$88,015 | \$2,640 | \$90,655 | \$45,328 | \$27,877,000 |
| 10 | Base HOV3+ - 4 Lanes(15% growth) | \$47,857 | \$27,630 | \$74,677 | \$150,164 | \$4,505 | \$154,669 | \$77,334 | \$47,561,000 |

1) Night revenue was approximated as 3 percent of AM, PM, and midday total.

2) Weekend day approximated as 50 percent of weekday total revenue.

3) Annual revenue assumes 250 weekdays and 115 weekend/holidays.

free travel to HOV-3+. Revenue potential is also reduced by adding additional capacity in the general-purpose lanes (Scenarios 3, 4, 7 and 8) or, in most cases, by reducing access to the MLs.

ESTIMATED WEEKDAY MANAGED LANE TRAFFIC

Figures 4-16 through 4-18 provide estimated traffic on the MLs, for each of the 10 scenarios. Figure 4-16 shows traffic estimates at 2015 levels for Scenarios 1, 2, 9 and 10. Scenarios 1 and 2 represent the basic project configuration in 2015 demand forecast, and differ only in whether or not HOV-2s are required to pay a toll to use the facility. Scenarios 9 and 10 represent the exact same physical alternatives and pricing structures, but reflect the higher growth (emulating year 2025) condition.

In each case, daily traffic levels are shown for each mainline segment of the MLs in blue. Peak hour (not peak period) volumes are shown in red and green, for the a.m. peak and p.m. peak, respectively. All figures are shown in thousands.

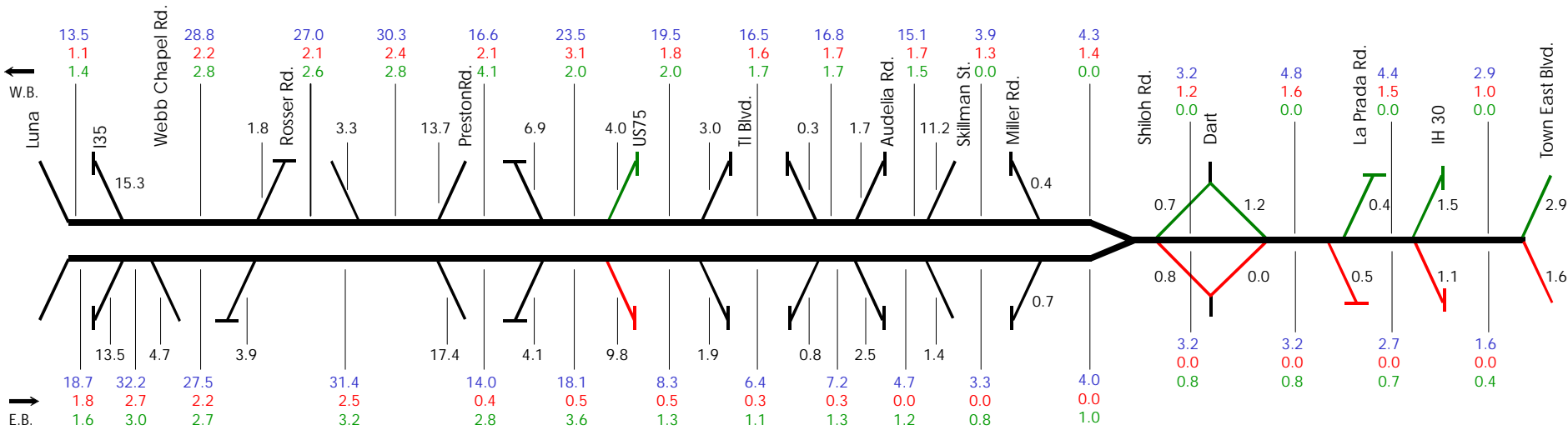
In addition to the mainline segment volumes, or estimated daily volumes on the access points are also shown, in black. In the interest of clarity of presentation, peak hour volumes are not shown on the ramp.

Note that the far eastern portion of the project is reversible; hence, there are no p.m. volumes shown in the eastbound direction or a.m. volumes shown in the westbound direction. Also, the direct access to and from U.S. 75 operates only in the westbound entering direction in the morning peak and the eastbound exiting direction in the afternoon peak. All volumes are shown separately by travel direction.

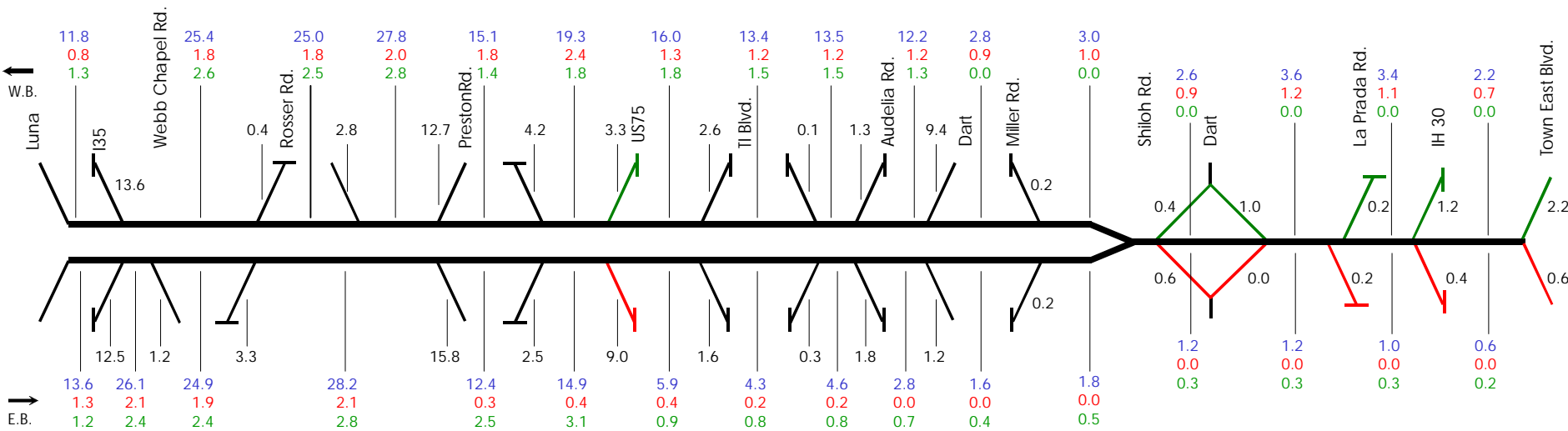
In general, the peak load point on the MLs would be in the vicinity of the DNT, or just west of Preston Road. At this location, total daily utilization is estimated at 61,700 vehicles per day. Peak hour volumes in each direction are generally between 2,400 and 3,200, well below the capacity of this six-lane managed lane section. This suggests substantial capacity exists to accommodate growth in the use of the ML facility as growth in corridor travel occurs or rate structures are modified to achieve some particular goal set like increased HOV use or increased VMT in the MLs, etc.

At the far east end of the project, in the reversible lane section, both daily and peak hour volumes are considerably lower. This is particularly true under Scenario 2, where HOV-2 traffic is required to pay a toll. Daily

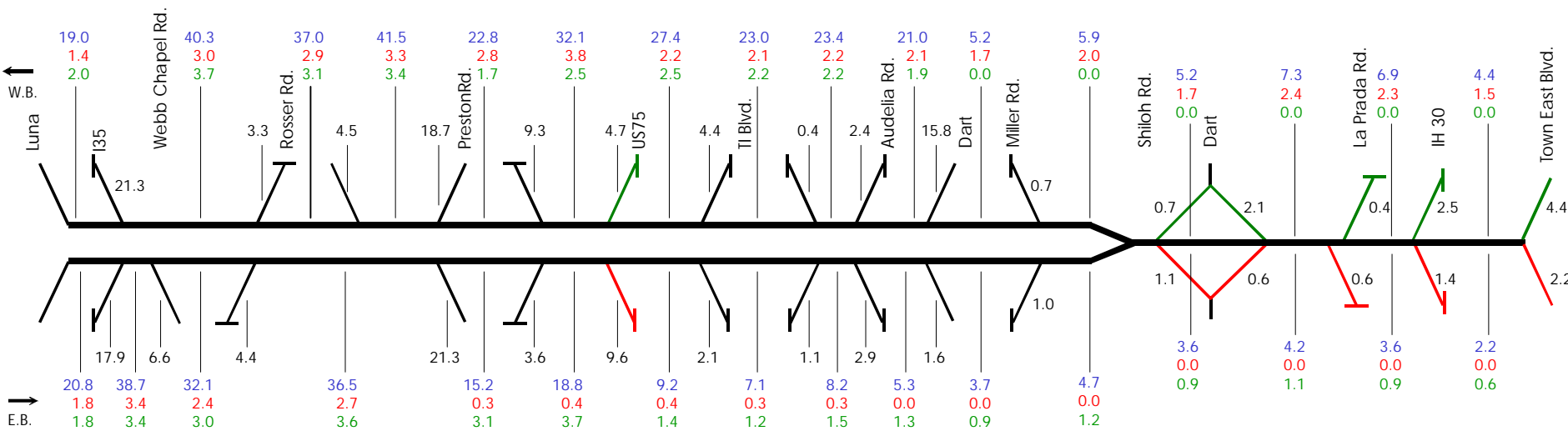
Scenario 1 – Year 2015, Base HOV 2+ Free



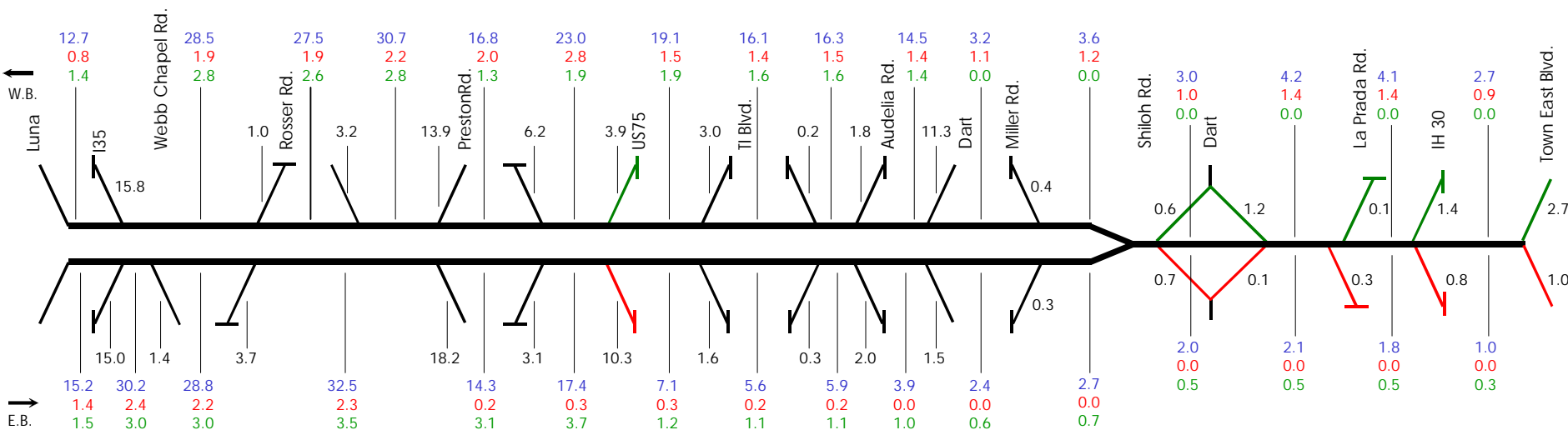
Scenario 2 – Year 2015, Base HOV 3+ Free



Scenario 9 – Year 2025, Base HOV 2+ Free-15% Additional Growth



Scenario 10 – Year 2025, Base HOV 3+ Free-15% Additional Growth



Managed Lanes

- Open A.M. Period (6:00am – 9:00am) Only
- Open P.M. Period (3:00pm - 7:00pm) Only

Legend

- Westbound Entrance, Eastbound Exit
- Eastbound Entrance, Westbound Exit
- Frontage Road Connection
- Intersection Street / Highway Connection

(Volumes in Thousands)

- 000.0 Daily Ramp Volumes
- 000.0 Daily ML Volumes
- 000.0 A.M. Peak Hour Volumes
- 000.0 P.M. Peak Hour Volumes

volumes of less than 5,000 are anticipated for Scenario 2 in this area. This is primarily due to the fact that this section of the MLs is reversible and would not be open during all hours of the day. Perhaps more importantly, the MLs would compete with five to six lanes of toll-free general-purpose capacity in each travel direction along much of this section of the roadway in the future. Hence timesaving advantages of the MLs are considerably less at the far eastern end of the project.

Scenario 9 is directly comparable to Scenario 1, except for the fact that a 15 percent higher global demand estimate is used. Similarly, Scenario 10 is comparable to Scenario 2; both restrict toll-free usage to vehicles with three or more occupants. Scenario 9 has the highest overall estimated traffic levels. While ML daily volume in the peak load point west of Preston is estimated at almost 80,000 vehicles per day, peak period hourly traffic estimates are still less than 4,000 in each direction, still below the capacity of the three-MLs in each direction at this location.

When reviewing the traffic estimates, particularly for Scenarios 9 and 10, it is important to recognize that these reflect toll rates, which will optimize toll revenue, and not necessarily maximize utilization of the MLs. The toll rate used in Scenario 10, for example, is considerably higher than the toll rate used in Scenario 2. If the same rates were used, traffic in Scenario 10 would exceed traffic in Scenario 2 by about 85 percent at many locations. However, revenue would be lower if the same toll rates were used.

In Figure 4-17, Scenario 1 is compared to Scenarios 5, 3, and 7 so that one can see what the effect of access to the MLs is for both the 4 and 5 lane configuration at one level of travel demand, i.e., 2015, and one toll regime, i.e., all HOVs ride free.

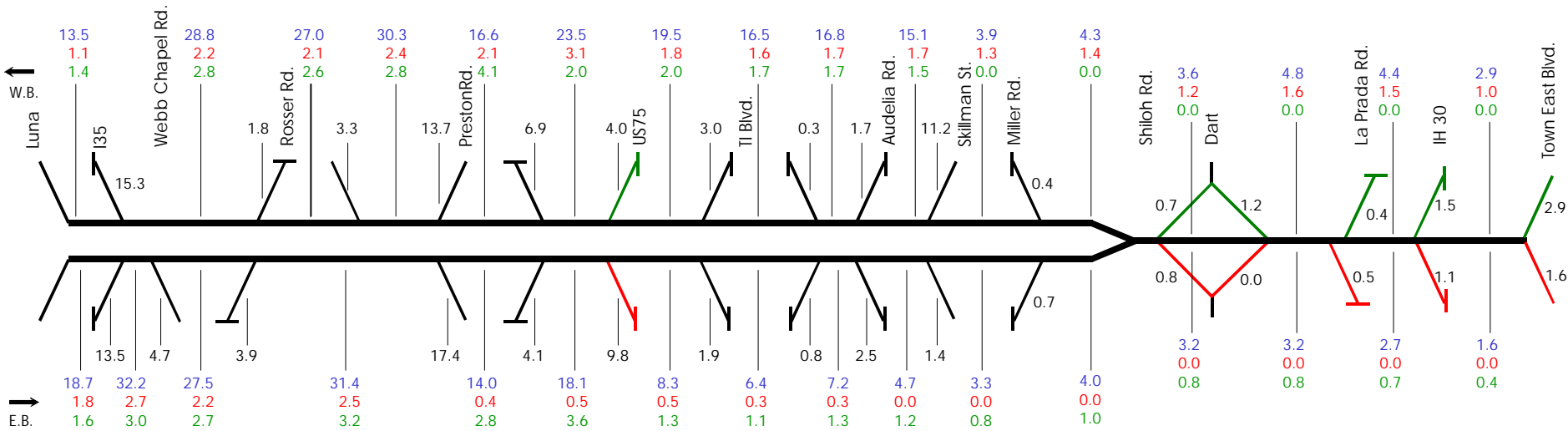
In Figure 4-18, the final set of comparative travel volumes is presented. Here, Scenario 2 is compared to Scenarios 6, 4, and 8. This facilitates the assessment of the impact on travel volume caused by reduced access with and without the 5th lane. All this is done at the HOV-3+ level of tolling, meaning HOV-2s are tolled.

TRIP VOLUMES ON THE LBJMLS AND GP LANES

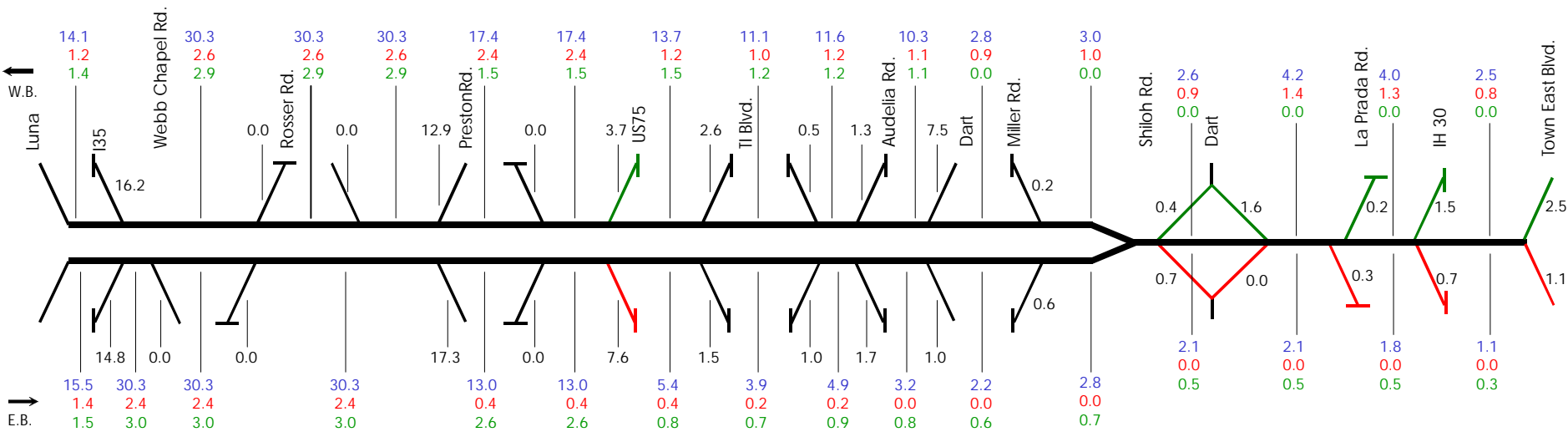
Estimated trip volumes on both the MLs of the LBJ and the GP lanes for Scenarios 1 and 2 are provided in Appendix B. Under these scenarios, the LBJ GP lanes are in a four-lane per direction configuration, and the travel demand is at the 2015 level.

Each figure contains the trip volumes for the a.m. Midday and p.m. periods for the MLs, the GPLs and the ramps to them both. The data is

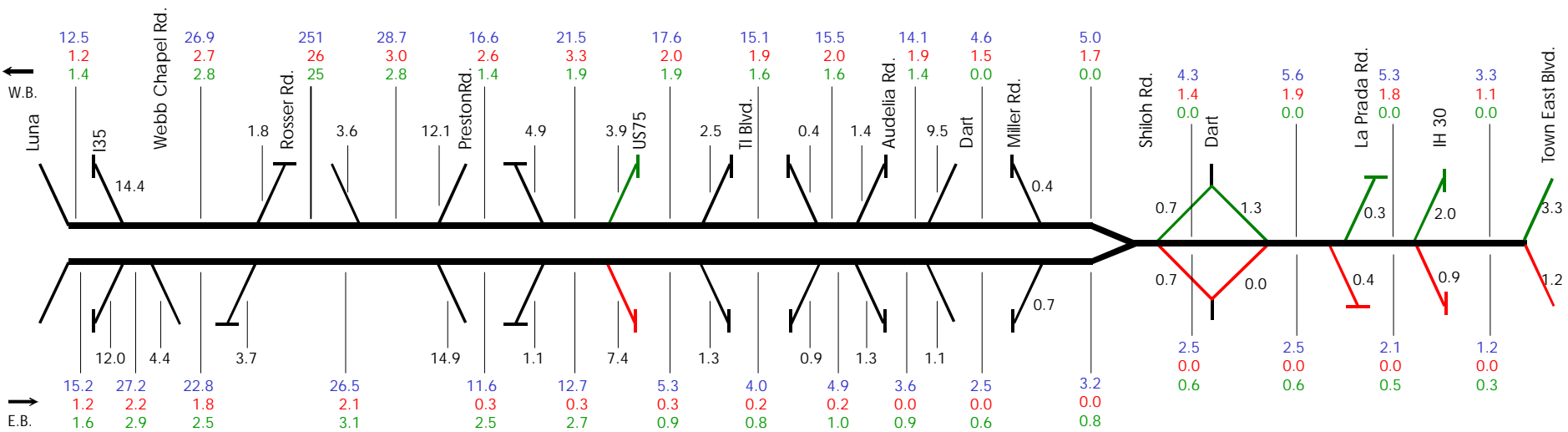
Scenario 1 – Year 2015, Base HOV 2+ Free 4 Lanes



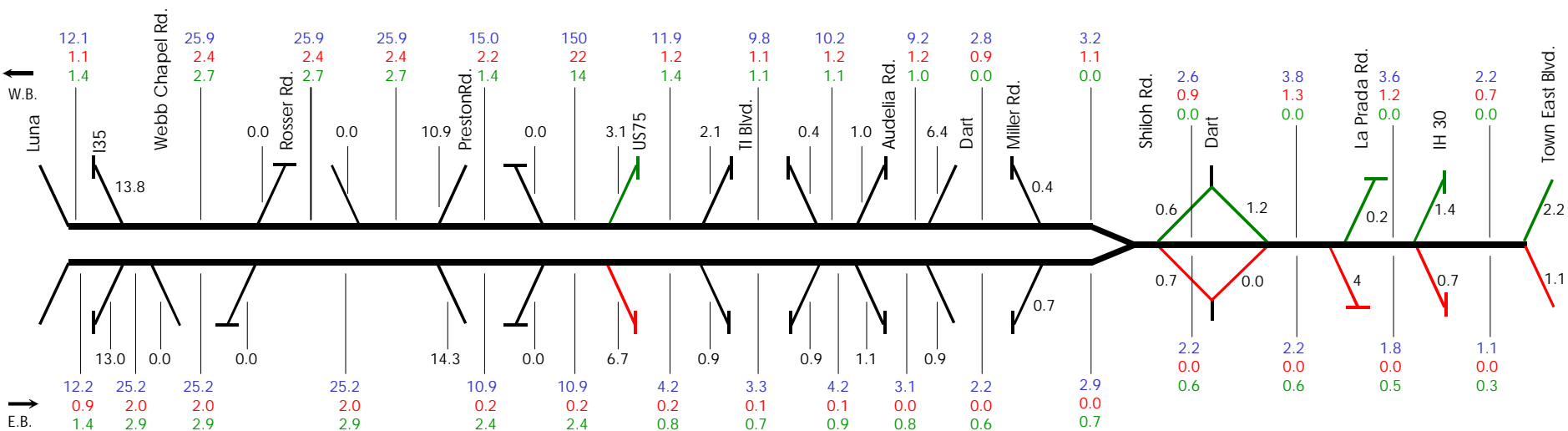
Scenario 5 – Year 2015, Reduced Access HOV 2+ Free 4 Lanes



Scenario 3 – Year 2015, Base HOV 2+ Free 5 Lanes



Scenario 7 – Year 2015, Reduced Access HOV 2+ Free 5 Lanes



Managed Lanes

- Open A.M. Period (6:00am – 9:00am) Only
- Open P.M. Period (3:00pm - 7:00pm) Only

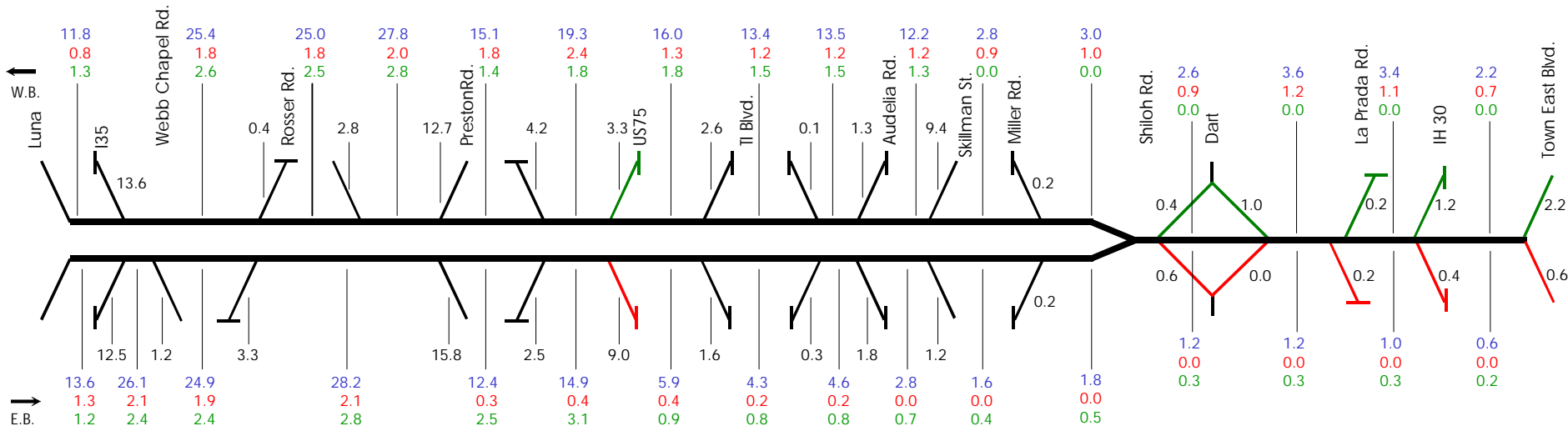
Legend

- Westbound Entrance, Eastbound Exit
- Eastbound Entrance, Westbound Exit
- Frontage Road Connection
- Intersection Street / Highway Connection

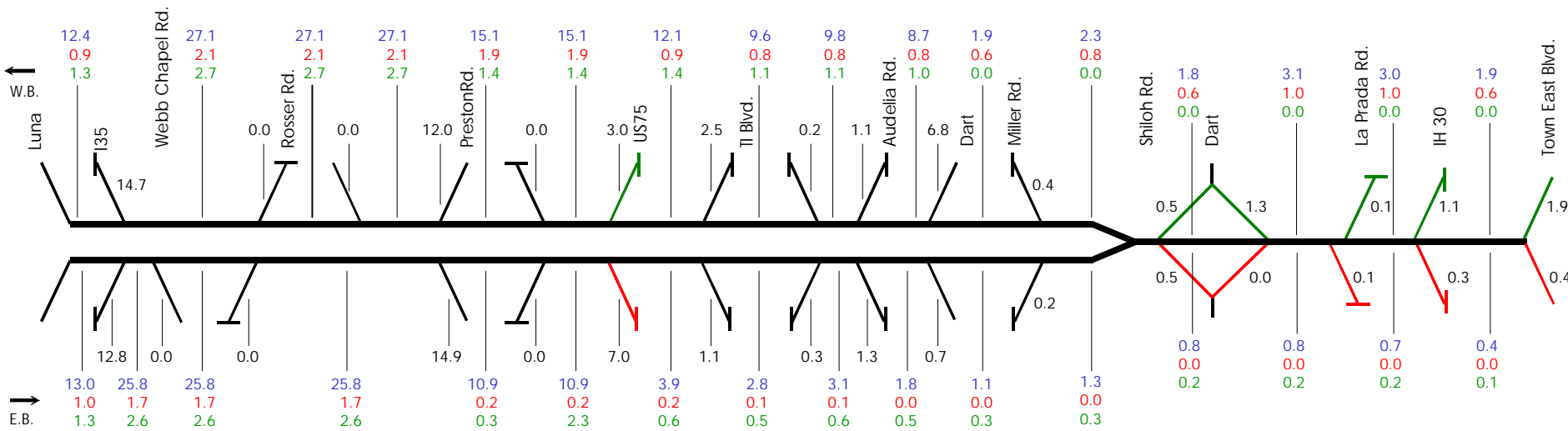
(Volumes in Thousands)

- 000.0 Daily Ramp Volumes
- 000.0 Daily ML Volumes
- 000.0 A.M. Peak Hour Volumes
- 000.0 P.M. Peak Hour Volumes

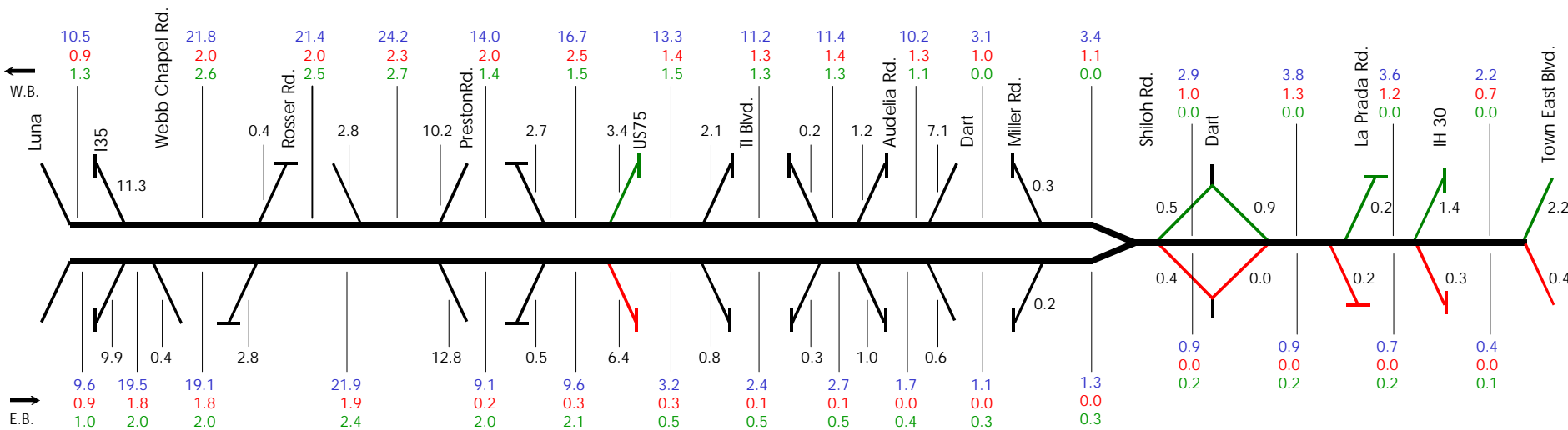
Scenario 2 – Year 2015, Base HOV 3+ Free 4 Lanes



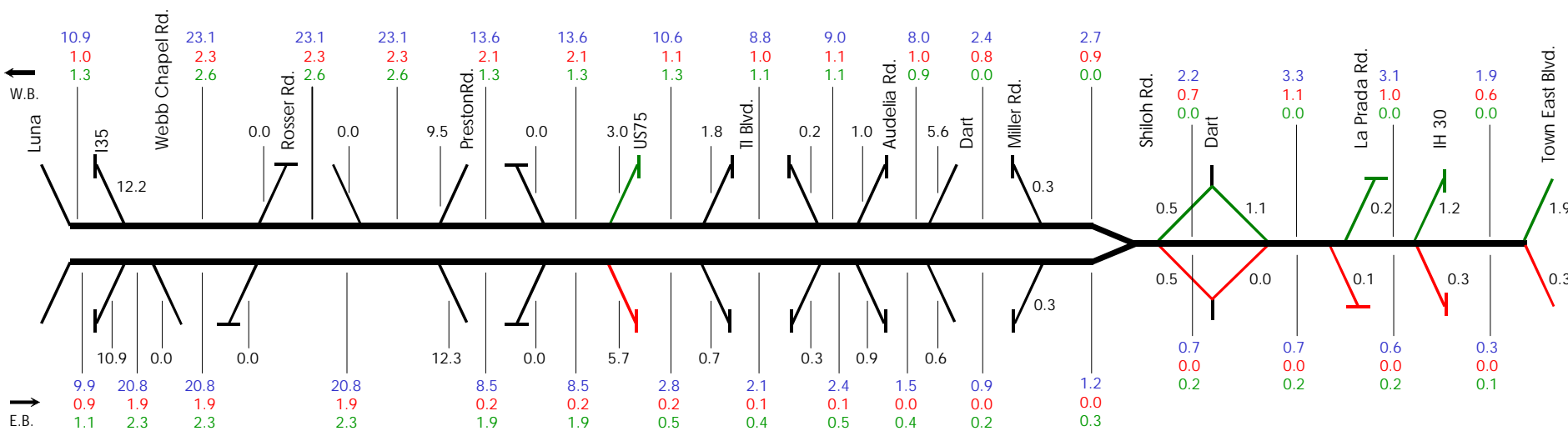
Scenario 6 – Year 2015, Reduced Access HOV 3+ Free 4 Lanes



Scenario 4 – Year 2015, Base HOV 3+ Free 5 Lanes



Scenario 8 – Year 2015, Reduced Access HOV 3+ Free 5 Lanes



Managed Lanes

Open A.M. Period (6:00am – 9:00am) Only

Open P.M. Period (3:00pm - 7:00pm) Only

Legend

/ Westbound Entrance, Eastbound Exit

\ Eastbound Entrance, Westbound Exit

Frontage Road Connection

Intersection Street / Highway Connection

(Volumes in Thousands)

000.0 Daily Ramp Volumes

000.0 Daily ML Volumes

000.0 A.M. Peak Hour Volumes

000.0 P.M. Peak Hour Volumes

organized by geographic section such that the eastern section's volumes is one chart for the three time periods for each scenario.

Appendix Figure B-1, then, presents trip volumes for ramps and links by time period for the western section for Scenario 1, i.e., all HOVs ride free. Appendix Figure B-2 presents similar data for the central section, and Appendix Figure B-3 presents trip volume for ramps and link by time period for Scenario 1 for the eastern section.

Appendix Figures B-4 through B-6 present trip volumes for ramps and links by time period for each geographic section of the LBJMLs for Scenario 2, i.e., HOV-2s tolled and travel demand at the 2015 level.

MLS TRAFFIC SHARE

Table 4-4 provides a summary of the estimated share of traffic of total LBJ demand, which would be expected to be accommodated at 2015 by the MLs. For each scenario, the table shows estimated total demand (in thousands of daily trips) by SOV, HOV-2 and HOV-3+ categories. In addition, for each scenario the number of trips in each occupancy category expected to use the MLs, for at least a portion of the journey, is also shown. The right side of the table shows the total travel demand that is accommodated on the LBJ in each category of travel.

Small differences in global demand on the overall LBJ facility relate to latent demand adjustments to the model, which were made as part of the analytical process. For example, in those scenarios where five GP lanes are provided, a slight increase in the total demand for LBJ is shown. A further increase is shown for Scenarios 9 and 10 which assume a nominal 15 percent growth in global demand on the corridor.

The number of trips assigned to the MLs by HOV-3+ is relatively stable between the scenarios, largely because on all scenarios HOV-3+ are expected to be free. However, it is interesting to note that under Scenarios 1 through 4, plus 9 and 10, only about half of all trips made by vehicles with three or more occupants would be expected to use the MLs, even without tolls. This is due to the fact that some trips are too short to take advantage of the MLs, recognizing the relative limited number of access points to and from the lanes. This is further exemplified by reviewing Scenarios 5 through 8, in which only about one-third of HOV-3 traffic uses the MLs, due to reduced ML access assumed in these scenarios.

Using the 2015 base trip tables, between 6 and 9 percent of SOV traffic is estimated to use the MLs, during the combined a.m. and p.m. peak period. This appears to be a relatively small share of traffic, but reflects both the

Table 4-4
Managed Lanes Traffic Share
Combined A.M./P.M. Peak Period Trips

| Scenario | Description | LBJ Total Demand (000) | | | |
|----------|--|------------------------|-------|--------|-------|
| | | SOV | HOV-2 | HOV-3+ | Total |
| 1 | Base HOV-2+ Free - 4 Lanes | 343.3 | 67.9 | 7.6 | 418.8 |
| 2 | Base HOV-3+ Free - 4 Lanes | 343.3 | 67.9 | 7.6 | 418.8 |
| 3 | Base HOV-2+ Free - 5 Lanes | 348.5 | 68.9 | 7.7 | 425.1 |
| 4 | Base HOV-3+ Free - 5 Lanes | 348.5 | 68.9 | 7.7 | 425.1 |
| 5 | Reduced Access HOV-2+ Free - 4 Lanes | 343.3 | 67.9 | 7.6 | 418.8 |
| 6 | Reduced Access HOV-3+ Free - 4 Lanes | 343.3 | 67.9 | 7.6 | 418.8 |
| 7 | Reduced Access HOV-2+ Free - 5 Lanes | 348.5 | 68.9 | 7.7 | 425.1 |
| 8 | Reduced Access HOV-3+ Free - 5 Lanes | 348.5 | 68.9 | 7.7 | 425.1 |
| 9 | Base HOV-2+ Free - 4 Lanes (Year 2025) | 396.5 | 78.1 | 8.8 | 483.4 |
| 10 | Base HOV-3+ Free - 4 Lanes (Year 2025) | 396.5 | 78.1 | 8.8 | 483.4 |

| Scenario | Description | Managed Lanes Trips (000) | | | |
|----------|--|---------------------------|-------|--------|-------|
| | | SOV | HOV-2 | HOV-3+ | Total |
| 1 | Base HOV-2+ Free - 4 Lanes | 28.2 | 25.5 | 3.9 | 57.7 |
| 2 | Base HOV-3+ Free - 4 Lanes | 29.4 | 10.4 | 4.0 | 43.8 |
| 3 | Base HOV-2+ Free - 5 Lanes | 22.4 | 25.0 | 3.9 | 51.3 |
| 4 | Base HOV-3+ Free - 5 Lanes | 25.0 | 9.6 | 3.9 | 38.5 |
| 5 | Reduced Access HOV-2+ Free - 4 Lanes | 27.4 | 14.6 | 2.5 | 44.6 |
| 6 | Reduced Access HOV-3+ Free - 4 Lanes | 24.5 | 7.8 | 2.6 | 34.8 |
| 7 | Reduced Access HOV-2+ Free - 5 Lanes | 21.3 | 15.8 | 2.5 | 39.5 |
| 8 | Reduced Access HOV-3+ Free - 5 Lanes | 23.3 | 8.2 | 2.5 | 34.0 |
| 9 | Base HOV-2+ Free - 4 Lanes (Year 2025) | 31.7 | 28.6 | 4.6 | 64.9 |
| 10 | Base HOV-3+ Free - 4 Lanes (Year 2025) | 33.7 | 12.0 | 4.6 | 50.3 |

| Scenario | Description | Managed Lanes Share (percent) | | | |
|----------|--|-------------------------------|-------|--------|-------|
| | | SOV | HOV-2 | HOV-3+ | Total |
| 1 | Base HOV-2+ Free - 4 Lanes | 8% | 38% | 52% | 14% |
| 2 | Base HOV-3+ Free - 4 Lanes | 9% | 15% | 53% | 10% |
| 3 | Base HOV-2+ Free - 5 Lanes | 6% | 36% | 51% | 12% |
| 4 | Base HOV-3+ Free - 5 Lanes | 7% | 14% | 51% | 9% |
| 5 | Reduced Access HOV-2+ Free - 4 Lanes | 8% | 22% | 33% | 11% |
| 6 | Reduced Access HOV-3+ Free - 4 Lanes | 7% | 11% | 34% | 8% |
| 7 | Reduced Access HOV-2+ Free - 5 Lanes | 6% | 23% | 32% | 9% |
| 8 | Reduced Access HOV-3+ Free - 5 Lanes | 7% | 12% | 32% | 8% |
| 9 | Base HOV-2+ Free - 4 Lanes (Year 2025) | 8% | 37% | 52% | 13% |
| 10 | Base HOV-3+ Free - 4 Lanes (Year 2025) | 9 | 15% | 52% | 10% |

restricted access and, of course, relatively high toll rates aimed at optimizing revenue. The share of SOV demand accommodated under each scenario could be increased if tolls were reduced.

A higher share of HOV-2 traffic is shown for those scenarios where HOV-2 is assumed to be toll-free. In most cases where HOV-2s are required to pay a toll, such as Scenarios 2 and 4, the share handled by the MLs is reduced to 14-15 percent. This is still higher than the SOV share, and reflects a higher value of time assigned to those multiple-occupant vehicles.

It is particularly interesting to note that there is an increased share of toll vehicles accommodated in the MLs when global demand is increased even by a nominal 15 percent. This is particularly impressive, however, recognizing that the increased share is in the face of an increase in real toll rates of about 75 percent between these two scenarios. If common toll rates were used between the comparable scenarios (e.g., Scenarios 2 and 10) total traffic in the MLs would increase by about 80-85 percent, (in comparison to the 15 percent increase in global demand), resulting in a much higher computed share of traffic in the ML.

Given the level of global demand modeled in this study, the MLs can be expected to carry up to 20 percent of total LBJ peak period traffic (both travel directions) depending on access, pricing and demand scenario. This number is significantly lower than active operational experience. Should new economic forecasts be carried out yielding a basis for travel more closely approximating levels demonstrated in Scenario 6.

COMPARATIVE SUMMARY OF SCENARIOS

Table 4-5 shows the assorted performance measures for each of the scenarios evaluated, i.e., Annualized Revenue, Daily Vehicle Miles Traveled in the MLs and average freeway speed in the direction with the slowest speed during the AM and PM peaks.

Beginning with Scenarios 1 and 2, it can be seen that in 2015, the revenues generated under the HOV-2+ scenario, (i.e., Scenario 1-all HOVs ride free), are only \$16.2 million. Should HOV-2 be tolled and let HOV-3+ ride free (Scenario 2), revenue increases to \$27.2 million, gaining an added 69 percent in revenues over the HOV-2+ free scenario.

Table 4-5
Comparative Summary of Findings

| Scenario | Description | Annual Revenue | Managed Lane Daily VMT | | Peak Period Speeds In General Purpose Lanes (MPH) | |
|----------|--|-------------------|------------------------|-----------|---|-------|
| | | | Toll | Toll-Free | AM-WB | PM-EB |
| 1 | Base HOV2+ Free - 4 Lanes | \$16,208,000 | 303,000 | 278,000 | 40 | 39 |
| 2 | Base HOV3+ Free - 4 Lanes | 27,156,000 | 438,300 | 25,900 | 37 | 37 |
| 3 | Base HOV2+ Free - 5 Lanes | 8,482,000 | 219,200 | 276,700 | 45 | 48 |
| 4 | Base HOV3+ Free - 5 Lanes | 16,110,000 | 348,800 | 28,100 | 43 | 44 |
| 5 | Reduced Access HOV 2+ Free - 4 Lanes | 16,671,000 | 321,000 | 195,000 | 38 | 38 |
| 6 | Reduced Access HOV 3+ Free - 4 Lanes | 24,069,000 | 401,900 | 18,100 | 35 | 35 |
| 7 | Reduced Access HOV2+ Free - 5 Lanes | 9,390,000 | 222,400 | 207,000 | 42 | 45 |
| 8 | Reduced Access HOV 3+ Free - 5 Lanes | 15,196,000 | 336,600 | 20,500 | 41 | 43 |
| 9 | Base HOV 2+ Free - 4 Lanes (Year 2025) | 28,213,000 | 402,300 | 300,000 | 32 | 33 |
| 10 | Base HOV 3+ Free - 4 Lanes (Year 2025) | 47,561,000 | 507,000 | 30,300 | 29 | 32 |

The speeds in the GP lanes fall from approximately 40 mph to 37 mph as one moves from HOV-2 riding free in the ML to HOV-2 being tolled in the ML portion of the LBJ.

To understand this result one can refer back to Table 4-4 to note that HOV-3+ represents a very small fraction of total vehicles on the road in this corridor. HOV-3+ comprise only about 1.8 percent of total traffic in the combined a.m. and p.m. peaks, i.e., 7,600 vehicle trips per day of a total of 419,000.

Table 4-4 shows HOV-2s comprise 16.2 percent of the total traffic on the LBJ. Almost 38 percent of them will use the LBJML when they are not tolled. However, once tolled, 60 percent of those that formerly were willing to pay the toll abandon the MLs.

To evaluate the impact of adding a fifth lane to the GP lanes for each direction while building the ML component as in Scenarios 1 and 2, Scenarios 3 and 4 were created. These scenarios evaluate ML usage with the added fifth directional GP lane at 2015 traffic levels with tolling being applied to:

- ✍ SOVs and HOVs with 2 or more people riding free, Scenario 3;
and
- ✍ SOVs and HOVs with 3 or more people riding free, Scenario 4.

As can be seen in Table 4-5, estimated revenue under the HOV-2+ falls to \$8.5 million per year as compared to the \$16.2 million collected under the same overall conceptual framework except with 4 directional GP lanes (Scenario 1). This represents a nearly 48 percent drop in revenues.

ML daytime VMT drops only 14 percent relative to Scenario 1, but more of the vehicles remaining are required to pay a toll.

If one looks at the composition of VMT in the first 4 scenarios in Table 4-5, one notices the obvious differences between Total VMT level under HOV-2+ vs. HOV-3+ within the matched pairs 1 & 2 and 3 & 4. It is clear why the Total VMT in the MLs will fall a greater degree under a tolling scenario that tolls HOV-2 when 5 directional GP lanes are available than when only 4 directional GP lanes are available. This occurs, because congestion is so substantially reduced in the GP lanes that there is less reason for the SOV-2 driver to want to pay a toll, i.e., 13 percent vs. 24 percent, respectively.

The free VMT is relatively constant across Scenario 2 vs. 4 and Scenario 1 vs. 3. There is, however, a significant difference in the tolled VMT across these matched pairs with both falling about 24 percent. Taken together, i.e., the effects of a reduction in tolling rates and a reduction in the numbers willing to pay a toll, there is a significant reduction in revenues.

The scenarios with five GP lanes per direction creates a sharply contrasting choice for the region: is it the best use of resources to build both a ML facility and a 5th GP lane in each direction. It would seem a closer evaluation of the costs and benefits of this choice is needed, based on the results we have seen in this analysis.

Speeds on the GP lanes in Scenarios 3 and 4 are seen to be significantly higher than the corresponding speeds in Scenarios 1 and 2, as one would expect given the added capacity of the fifth GP lane. However, there is still the 2-3 mph decline in the GP lane travel speed when one compares GP lane travel speeds under HOV-2+ vs. HOV-3+.

Scenarios 5 through 8 are identical to 1 through 4 except that they refer to the reduced ML access proposals shown in Figure 4-1. By reducing access one might expect a reduction in revenues, but what the analysis shows is that by reducing access, the ML users are forced to choose to suffer congestion or get on the ML earlier. In Scenarios 5 and 7, where all HOVs ride free, a small percentage has chosen the option of getting on sooner thereby increasing revenues by about 5 percent or less.

In Scenarios 6 and 7, a reduction of revenues occurs as tolls are applied to SOV-2s and they then flee the tolled lanes. While they add substantial congestion to the GP lanes, the added inconvenience to the overall traveling population does not result in enough of them getting on earlier to overcome the loss of SOV-2 revenues to the degree that occurred in Scenarios 2 and 4, respectively.

Scenarios 9 and 10 show the effects of higher total travel levels on the LBJML facility. With all HOVs riding free at this overall level of travel demand, we would expect to generate \$28.2 million. This is roughly equivalent to the toll revenues generated by tolling HOV-2s in Scenario 1. If one tolls HOV-2s at the 2025 travel demand level, then one could expect to receive \$47.6 million in tolls, as shown in Scenario 10.

Had toll rates remained constant, one would have seen a far greater growth in VMT on the MLs and travel times on the MLs would have risen substantially. By increasing the toll rates as demand grows, travel timesaving are preserved on the MLs and the region retains a travel

platform in the LBJ corridor that maintains mobility in the face of growing corridor congestion.

Speeds in the GP lanes are reduced by about 5-8 mph or about 20 percent to 30-32 mph for Scenarios 9 and 10 while speeds in the MLs are either at or above 60 mph.

SUMMARY

Given the structure of the scenarios and economic and demographic data used to support those scenarios, the forecasted levels of traffic and revenue for the LBJMLs completed in this study can be useful in evaluating the efficacy of building five GP lane vs. the four GP lane alternatives. By reviewing the performance measures reported in this chapter of the four-lane scenarios, Scenarios one and two, as compared to the five lane scenarios, three and four, one can see a rather substantial reduction in revenues occurs, amounting to 40-48 percent, if the five GP lane alternative is built as compared to the four lane.

The VMT reduction in the MLs for five GP lanes vs. four GP lanes alternatives varies from approximately 14 to 19 percent depending on the tolling policy for HOVs that is pursued. The fall off in VMT is less than the revenue fall off, because even as congestion on the GP lanes falls in the five lane scenario as compared to the four lane scenario, enough congestion remains to encourage a sizable number of drivers to continue to use the tolled MLs at a substantially reduced toll rate.

The variation in revenues and VMT within each pair of strategies, i.e., 1 and 2 or 3 and 4, is caused by the choice of tolling policies, i.e., tolling HOV-2s and SOVs vs. allowing all HOVs to use the MLs at no charge and just tolling SOVs.

While the five GP lane Scenario provides relatively higher travel speeds for the GP lanes, it comes at a very steep cost to the revenues generated in the ML. Clearly policymakers will have to evaluate the operations and objectives they anticipated the facility would achieve as opposed to revenues generated to see if sufficient returns are achieved in these two critical measures of facility performance under the four GP lane vs. five GP lane scenarios.

Of course the construction costs of the five GP lane scenarios as opposed to the four GP lane scenarios would play a large role in the policy decision as to whether to build the four or five GP lane facility. That information is beyond the scope of this study but is available to policymakers. Forecasted

traffic and revenue for Scenarios 9 and 10 provide results that also will be of assistance to policymakers in making this decision. Those scenarios are discussed below.

The study team also evaluated building fewer access ramps to the ML facility. The effects of reduced access to the MLs that can be best seen by comparing Scenarios 1 and 2 to 5 and 6, i.e., full access vs. reduced access, for the four GP lane configuration. For the five GP lane configuration, Scenarios 3 and 4 should be compared to Scenarios 7 and 8.

The results suggest that the reduced access to the ML lanes apparently constrains its use by car-poolers. The effect of this outcome is to drive up congestion in the GP lanes thereby creating more of an incentive for SOVs to pay a toll. So the revenues increase as access is constrained, see tolled VMT and annual revenue, Scenario 1 vs. 5, i.e., the four GP lane configurations.

When SOV-2s are tolled in the constrained access configurations, the increase in congestion caused by their reduced use of the MLs is not sufficient to cause enough delay to warrant SOV drivers to raise their use to levels exceeding the base configuration level of revenue, so revenues fall by about 13 percent in the four GP lane alternative relative to the base configuration with four GP lanes, see Scenario 2 vs. Scenario 6.

A similar relationship holds for the five GP lane configurations in the constrained vs. the base-case access Scenarios, see Scenarios 3 and 4 as compared to 7 and 8, respectively, except that the use of MLs and the revenues produced by the ML are markedly lower due to the relatively high level of capacity in the GP lanes given the added fifth lane.

Scenarios 9 and 10 were developed to demonstrate the effect of growth on the use of the MLs. To see this effect one need compare Scenario 1 to Scenario 9 and Scenario 2 to Scenario 10. Structurally, the Global Demand in Scenarios 9 and 10 is 15 percent higher than that utilized in all of the other Scenarios.

When Scenario 1 is compared to 9, one can see a 75 percent increase in revenue while the VMT grows by only 20 percent. This clearly demonstrates the effect on the traveling public of increasing congestion and the resultant travel time savings increase one can gain from use of the MLs.

When Scenario 2 is compared to Scenario 10, there is a similar increase of 75 percent in revenues but only a 15 percent increase in VMT in the ML.

The added congestion in GP lanes caused by both the HOV-2s having to pay a toll and the SOVs being present in greater numbers result in relative increase in travel time being sufficient to create a substantial increase in revenues with only 1/5th the increase in VMT in the MLs.

This demonstration shows the importance of having very accurate forecasts for regional population and employment. This work was done without the benefit of the Year 2000 Census and was completed before the announcement of significant government contract awards that could substantially increase travel and development in this corridor. In addition, it is clear that both DART, Tri Rail and TxDOT are proposing to make very substantial investments in infrastructure in this corridor which will significantly increase its accessibility and attractiveness as a location for manner of activities.

Given these developments, it would seem prudent to undertake further evaluations of a reduced set of the scenarios presented in this report, but with the benefit of more recent estimates of population and employment growth for the region. Should these forecasts show just a small annual growth rate increase coupled to somewhat different distributions of origins and destinations brought on by new development or re-development activities, the facility could show markedly different VMT and revenue results.

Obviously this facility is not a private toll road run for profit maximization. Current policy analyses undertaken within the transportation planning professions would suggest that a sensitive balance must always be maintained between the pursuits of revenue generated as compared to the speeds in the GP lanes or the political consensus needed for the construction of a network of ML facilities in the region might be seriously jeopardized.

Clearly, these Scenarios do not depict any conflict such as this, but under some higher growth scenarios, attention to such issues might be warranted. However, should this become an issue, the LBJ Freeway corridor has within it the ability to accommodate five GP lanes. This circumstance allows policymakers to construct a four GP lane configuration and observe the system performance as population and economic development expand in the region. Should travel speeds begin to deteriorate too dramatically in the GP lanes relative to that of the MLs, then it would be possible to add the fifth lane so that GP lane performance would not be too significantly different from ML performance. The selection of this implementation strategy should likely await the preparation of traffic and revenue forecasts based on Year 2000 Census. Furthermore, it should not be made in the

absence of consideration of construction cost information for each scenario, but it is clear using just the information in this study that the 5 GP lane scenario seriously erodes the use of the tolled managed lanes.

The other major decision that could be evaluated using information developed in this study is the determination as to whether one should build a reduced access configuration or a base-case access configuration. While there is information presented in this study to inform such a decision, it would be prudent to put that decision off until better information related to population and employment in future years is available. The distribution and levels of these demographic and economic dimensions of the transport modeling process could materially affect that decision. Of course the costs of construction of the various scenarios would also play a major role in this decision.

The last significant result of this traffic and revenue study is the demonstration of the impact of forecasted levels of traffic on the ramp connecting the MLs to the GP lanes in the vicinity of Preston Road in the eastbound direction and the ramp connecting the ML to U.S. 75 in the P.M. time period in the eastbound direction. In both instances, significant cues are created by the lack of capacity of these exit ramps which result in congestion on the MLs.

The design of these ramps should be thoroughly investigated to determine if added capacity can be provided. By adding capacity to these ramps, significant improvements in ML operations can be secured. This could prove critical if growth in the corridor, as depicted in scenarios which utilized more current data, prove to be higher than anticipated in the first eight scenarios that were investigated. This can only be certified through the analysis of the facility design over a multi-year simulation period and with an updated economic forecast for the corridor that accounts for both:

- ✍ the massive investment in infrastructure in the corridor to enhance mobility, accessibility and economic development potential, and
- ✍ the effects of traffic growth on the traffic flow characteristics imbedded in the facility design.

OPPORTUNITIES FOR INNOVATIVE NON-TRADITIONAL REVENUE STREAMS AND THEIR EFFECT ON REGIONAL TRAVEL AND ECONOMIC DEVELOPMENT

As noted in previous sections in this report, the LBJML facility presents the region an opportunity to create a platform for BRT services operation. Should the region proceed to implement other ML facilities as is potentially possible given the conceptual regional HOV plans that are currently being evaluated in greater detail, a wide ranging service plan for BRT could potentially be supported.

While BRT offers another form of mobility to the suburban traveler, it also holds the potential to deliver substantial real estate windfalls to developers, renters and/or purchasers of real estate in the BRT corridor. Through creative financing partnerships, these returns could be used to support a widespread implementation of MLs in the region. Should the region choose to pursue these returns, it could enhance the economic and financial performance of the LBJML facility and others like it by orders of magnitude. It would achieve these benefits by intensifying development on parcels adjacent to the facility in a fashion that would seem to fly in the face of common logic. In effect, this facility could promote better access by increasing density of development in the very area where congestion is at its worst.

Not only does this produce substantially higher returns on both public-sector infrastructure and private-sector real estate investment, but also this strategy would soak up development that might otherwise push out further into the countryside. The efficiencies that both of these outcomes yield for both the public and private sector will in turn result:

- ✍ In far higher rates of productivity growth;
- ✍ Higher levels of mobility for the given amount of transport dollars expended; and
- ✍ A far more competitive regional economy.

A series of studies would need to be completed to scale, locate and identify specific packages of development that could be supported by the LBJML/BRT facility concept. Given experience elsewhere, potential returns could be very high. Information as to the level of return could be among the first studies undertaken. If it proved attractive, then the region could undertake the subsequent policy studies on the synergies available from the integrated development of MLs and real estate by both the public and private sectors along the LBJ corridor.

CHAPTER 5

———— TOLL OPERATION CONCEPTS

Toll collection technology has changed dramatically over the past 10 years. The industry has gone from “conventional” toll collection, utilizing automatic coin machines and toll collectors collecting a flat fee, to ETC generally using some form of dedicated short range communication (DSRC) technology.

ETC has been in use in the Dallas area for many years. In fact, the DNT was the first U.S. facility to employ the current generation of ETC. Several hundred thousand “Toll Tags” are in use in the region, accepted on all of the toll facilities operated by the NTTA.

Given the nature of the proposed LBJML project, it is inevitable that toll collection will be fully electronic. All similar types of managed lanes facilities, including S.R. 91 and I-15 in California, utilize fully-electronic automated toll collection.

This study has considered a horizon year of 2015. While portions of the LBJML may well be open in advance of that, it is still several years before the project will open. As such, it is reasonable to assume major changes in ETC technology before the managed lanes open. Indeed, it is possible that almost all vehicles in the region will be equipped for electronic pricing of some type by the time major portions of the MLs are opened.

TECHNOLOGY OVERVIEW

The ETC system now in use in the Dallas area generally utilizes a “read-only” approach. That is, the electronic transponder is used to identify the vehicle and electronic toll account balances are maintained on a central computer system. This is typical of most ETC systems in use in the U.S. today.

However, many newer systems include “read-write” capability on the transponder. This is a significant improvement and could be quite important in developing a toll collection concept for the managed lanes, as will be described below.

Future direction for ETC may well include the integration of a “smart card” into the transponder device. Not only does this offer improved opportunities for privacy, but also would allow even further flexibility in variable pricing systems and ultimately integrated electronic payment between modes.

With smart cards, it would be possible to maintain pre-paid account balances on the card itself, obviating the need for centralized accounting. This would also allow for increased opportunities for joint usage, such as electronic payment of parking and/or transit fares. Today, the same Toll Tag or transponder used on the NTTA facilities can also be used for parking charges at DFW Airport. However, motorists desiring to use this service must establish separate accounts for the Airport and toll facilities with only the transponder number being the common element.

Future use of a smart card might also facilitate handling of HOV segregation, as will be discussed below.

Going into the analysis, WSA was advised to assume that all vehicles using the managed lanes, whether HOV or not, would be required to be equipped with an electronic toll transponder. This is an important assumption, and is probably not unreasonable given the rapid emergence of ETC and the growing interest in road pricing strategies in major urban areas. However, it would still be possible to develop an auditable electronic toll system to meet the needs of the managed lanes even if some vehicles (e.g., HOV) were permitted to use the lanes without transponders.

PRICING CONSIDERATIONS

In developing an ETC concept for the managed lanes, certain basic assumptions regarding pricing program parameters were taken into consideration. These include:

- ✍ Pricing will be “distance-based,” meaning that the toll charged will be a function of distance traveled on the managed lanes – possibly including certain “minimum tolls” for very short trips;

- ✍ The managed lanes will employ some form of variable toll collection, with higher toll rates charged in peak periods and lower rates charged during less congested times;
- ✍ The possibility of the use of “dynamic” pricing is also to be considered. This is now in use on the I-15 Managed Lanes project in San Diego – whereby the toll rate is almost continually adjusted based on certain traffic measurements, such as volume in the managed lanes; and
- ✍ High-occupant vehicles (HOV) are assumed to be permitted to travel in the managed lanes toll free – the definition of HOV is either 2+ or 3+ - provisions therefore must be made in the system concept to distinguish between toll paying and toll-free vehicles.

The proposed LBJML would be significantly more complex than any of the existing managed lanes facilities now in use. Most notably, the project would be much longer with several intermediate access points, which will add complexity to the variable toll structures, and advanced signing information systems to motorists, particularly if dynamic pricing is used.

DESIGN CHALLENGES AND OPPORTUNITES

In developing a potential ETC concept, a number of design challenges and opportunities needed to be addressed, including:

- ✍ Methods for delineation between HOV and non-HOV traffic, in a way which will ensure that HOV vehicles are not tolled while all non-HOV traffic is;
- ✍ Enforcement of both toll collection and HOV compliance – an element which can be very critical to revenue preservation and overall financial feasibility of the project;
- ✍ Interoperability between the electronic tolling system on the managed lanes over other toll facilities in the DFW region, both existing and planned for the future;
- ✍ Potential for integrated electronic payment, covering not only the managed lanes and other toll facilities, but also parking and transit – this would create opportunities to add an additional demand management element through pricing strategies which might encourage intermodal shifts to rail or bus transit, for example; and

- ✍ Motorists advanced information systems regarding toll rates in affect at any given time, a particular challenge given the multiple access points and potential for dynamic pricing.

The traffic and revenue study has assumed the use of mileage-based variable tolls. These could be either fixed variable or dynamic pricing; although dynamic pricing might offer the best opportunity for true demand management between the main lanes and the managed lanes.

OVERVIEW OF “OPEN ROAD” ELECTRONIC TOLLING

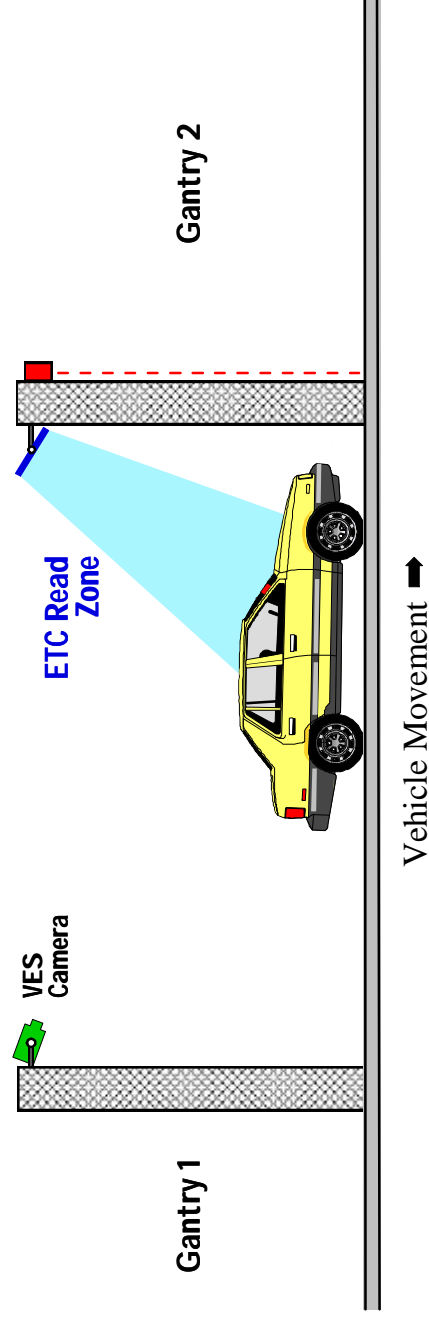
In the subsequent sections, number of alternatives for a fully ETC system on the managed lanes will be presented and discussed. However, it is useful to first provide a brief overview of the basic elements of fully electronic, open road tolling to better understand the various specific alternatives for the LBJMLs.

Figure 5-1 shows the typical ETC read/enforcement process in a non-stop environment. While there are several variations, a typical approach would involve the construction of two gantries across the electronic “tolling zone.” Gantry 1 would primarily support the violation enforcement (VES) camera and lighting equipment. The actual ETC antenna, shown in blue in Figure 5-1, would be mounted on the downstream gantry. Also on that gantry would be a laser vehicle separator of some type, shown in red in Figure 5-1. This device is used to detect the beginning and end of each vehicle, critical in vehicle classification, violation enforcement and to ensure linking of appropriate electronic toll transponder with each appropriate vehicle.

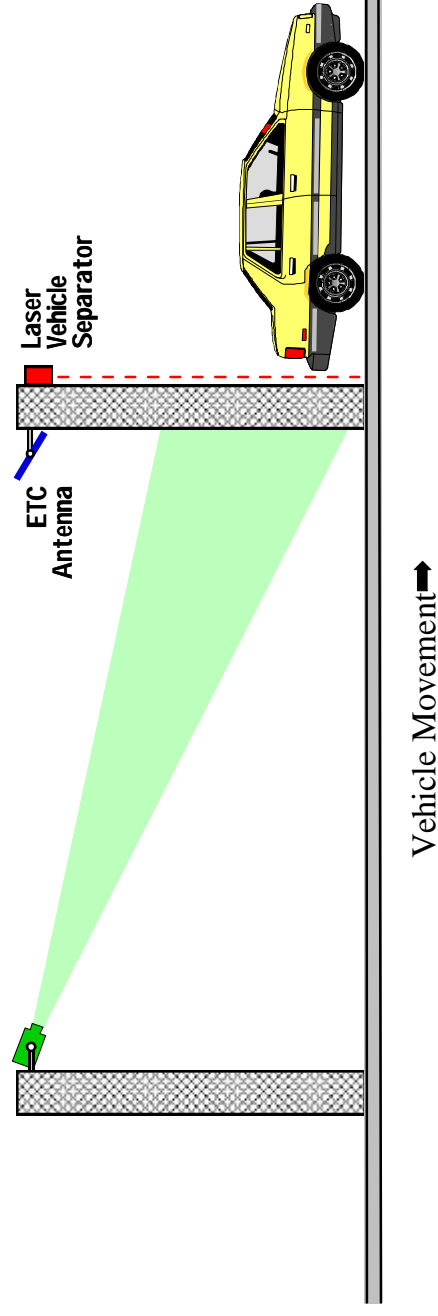
The vehicle initially passes under the first gantry; typically before arriving at the second gantry the electronic toll antenna reads the transponder account number and validates the transaction. As the vehicle clears the laser vehicle separator mounted on the downstream gantry, a digital image of the rear license plate is triggered from the VES camera, actually located on Gantry 1. If the transaction is valid, the digital image is not saved. However, if it is a violation (i.e., no electronic toll transponder or no money in the account, etc.) the digital image of the license plate is saved for later violation processing.

It is possible to place all of this equipment on a single gantry, such as is done in Melbourne, Australia, but not typical. However, where no more than two lanes are involved, it would be possible to mount the VES equipment on the roadside, obviating the need for one of the gantries.

Vehicle Passes Under ETC Reader on Downstream Gantry



If Violation, Trailing Edge of Vehicle Breaks Detector Field - Triggers Video Image of Rear Plate



ELECTRONIC TOLLING CONCEPT ALTERNATIVES

As described previously in this report, depending on the physical alternative ultimately implemented, there may be as many as 34 entrance and exit points over the 20-mile distance of the managed lanes project. There are generally four types of access being considered:

- ✍ Entry and exits at each end of the project;
- ✍ Ramp entry and exit to/from the frontage roads;
- ✍ Direct entry and exit between the managed lanes and the LBJ freeway main lanes; and
- ✍ Direct ramp entry and exit to/from intersecting routes or intermodal interface points.

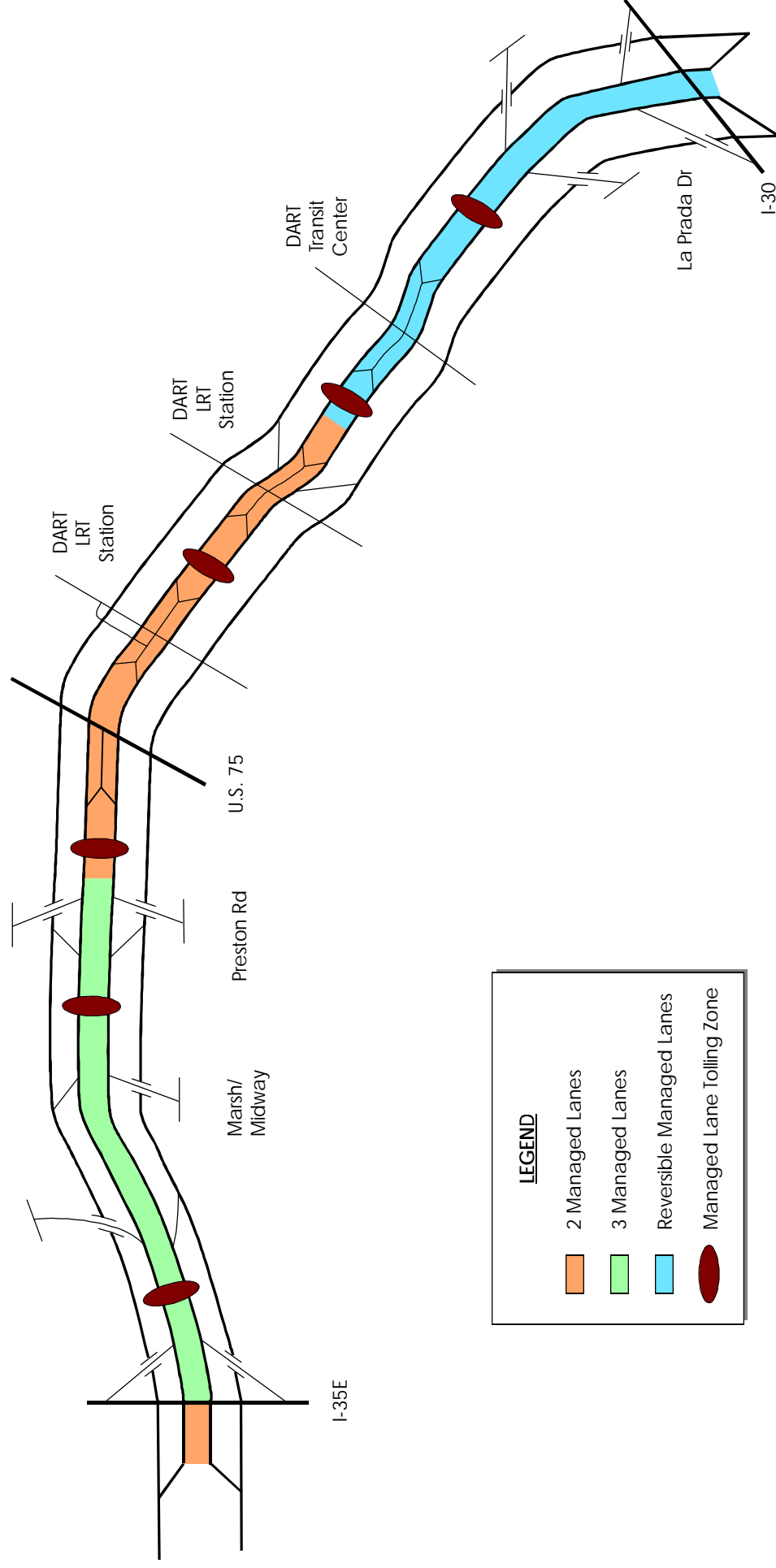
The eastern one-third of the project will include only a two-lane reversible roadway. The reversible roadway would be opened in the westbound direction during the a.m. peak period, the eastbound direction during the p.m. peak period and closed at other times.

Given the assumption that tolls will, in some way, be based on distance traveled, two basic alternative tolling concepts have been identified:

- ✍ Alternative 1 – A series of “mainline tolling zones” located at strategic locations across the roadway in the form of clear-span gantries. This is similar to the fully-electronic toll system now in use on the City Link project in Melbourne, Australia; and
- ✍ Alternative 2 – An entry/exit electronic “closed” system in which electronic toll readers and gantries were located on all entry and exit ramps with the toll determined based on point of entry and point of exit. This type of system is now in use for ETC traffic on Highway 407 in Toronto, Canada, another fully-electronic major urban toll facility.

ALTERNATIVE 1

The tolling concept for Alternative 1 is shown in Figure 5-2. As shown, approximately six mainline gantries, or tolling zones would be required to provide full coverage of all possible movements. With these six locations, it would not be possible to use the MLs without passing through at least one tolling zone.



The toll rates associated with each gantry would be adjusted based on the distance “covered” by each tolling zone as well as the price in effect at any given time. If a vehicle traveled, say, between I-35E and U.S. 75, it would pass through three tolling zones, while a vehicle entering at I-35E and exiting at Midway Road would pass through just one.

The toll charges for each trip would, of course, be based on the number of gantries the vehicle passed through. The tolling zones would be largely “transparent” to the users, and would not require a stop. However, it might be necessary to provide separate “toll lanes” to distinguish between HOV and non-HOV (toll versus toll-free) vehicles. This is the approach currently used on the S.R. 91 Managed Lanes project in California, as shown in the photograph in Figure 5-3. Vehicles with three or more occupants are directed to use the leftmost lane while vehicles with two or less occupants pass through the two righthand lanes, at full freeway speeds, thereby electronically adjusting toll rates.

While the open gantry system would be relatively simple to implement, there are a number of disadvantages, when compared to some type of entry/exit closed system. Some of these include:

- ✍ The ability to have minimum or maximum tolls would become complex, and might require “trip reconstruction” to determine the number of gantries a given vehicle went through on a given trip to make appropriate toll adjustments – this has been the most significant problem experienced in the toll system on the Melbourne City Link project;
- ✍ Dynamic variable tolls may be used, where the toll rate is continually adjusted every few minutes. The multiple gantry system would prove to be extremely complex since the per-mile rate for a given vehicle should remain the same once that vehicle enters the managed lanes. Advance signing would have advised the motorist what the prevailing rate is at the time the vehicle entered; it would be inappropriate to have that rate change while the vehicle was in the managed lanes with no opportunity to leave. As such, it would be possible that two or three different vehicles passing below the same gantry at the same time might be charged three different rates depending on the time and place where that vehicle entered the system;
- ✍ Statistical reporting and trip information would be much more complex, as would the ability to monitor travel pattern data to possibly adjust pricing for optimum utilization;



3-Lane Tolling Zone and Support Gantries

Courtesy of California Private Transportation Company



Electronic Toll Collection Antennas



Tolling Zone Approach With HOV Segregation

SR 91 TOLLING ZONE WITH HOV SEGREGATION

FIGURE 5-3

- ✍ Opportunities for intermodal pricing strategies, such as reduced tolls if the motorist transfers to a transit mode, would be much more difficult; and
- ✍ If HOV channelization were required, this would require considerable additional weaving to HOV traffic, as many as six times within a 20-mile ride.

Given the nature of the facility, it may also be difficult to construct electronic toll gantries at some of the locations indicated. Optimally, it would also be good to be able to widen the roadway for short distances in the vicinity of tolling zones to allow for occupancy delineation; this may also be difficult given current design plans.

ALTERNATIVE 2

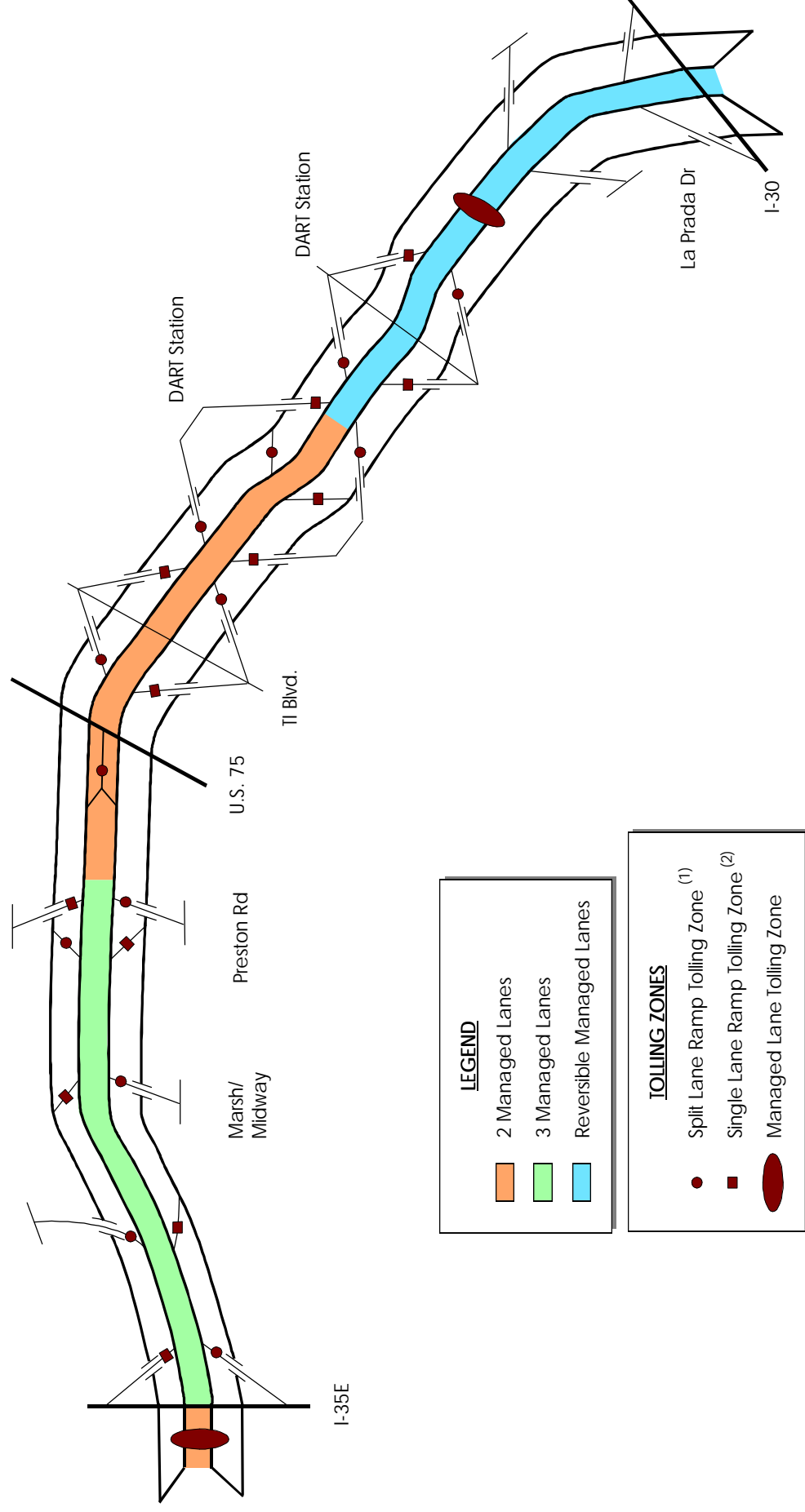
Figure 5-4 shows a proposed tolling concept with tolling zones located at all entry and exit locations. Small mainline tolling zones would be required at the west and east ends of the facility. The eastern mainline tolling zone would be located west of the La Prada Drive access ramp; hence vehicles using any of the ramps further to the east would be assessed the same toll.

This overall concept would have two suboptions:

- ✍ Alternative 2-A which would feature “split-lane” entry ramp tolling zones which would be used for distinguishing between HOV and non-HOV traffic; and
- ✍ Alternative 2-B which would not provide the physical separate of HOV and non-HOV traffic and would handle delineation through either smart cards or other visual monitoring techniques.

The configuration shown in Figure 5-4 generally reflects Alternative 2-A. Each of the entry ramp locations would be widened for a short distance into two lanes, one designated for HOV and one for toll vehicles. By using this approach, in conjunction with either smart cards or read-write transponder technology, it would be possible to “write” at the time of entry the following information on the transponder:

- ✍ Point of entry;
- ✍ The exact time of entry;
- ✍ Toll rate in affect at the time of entry; and
- ✍ Whether the vehicle was HOV or non-HOV.



(1) Split Lanes Needed in Alternative 2-A Only;

(2) In Alternative 2-A, Split Lanes May Be Required at Exit Locations if HOV Vehicles Without Transponders Allowed to Use Managed Lanes.

LBJ ML ELECTRONIC TOLL SYSTEM CONFIGURATION
Alternative 2 – Entry/Exit System

FIGURE 5-4

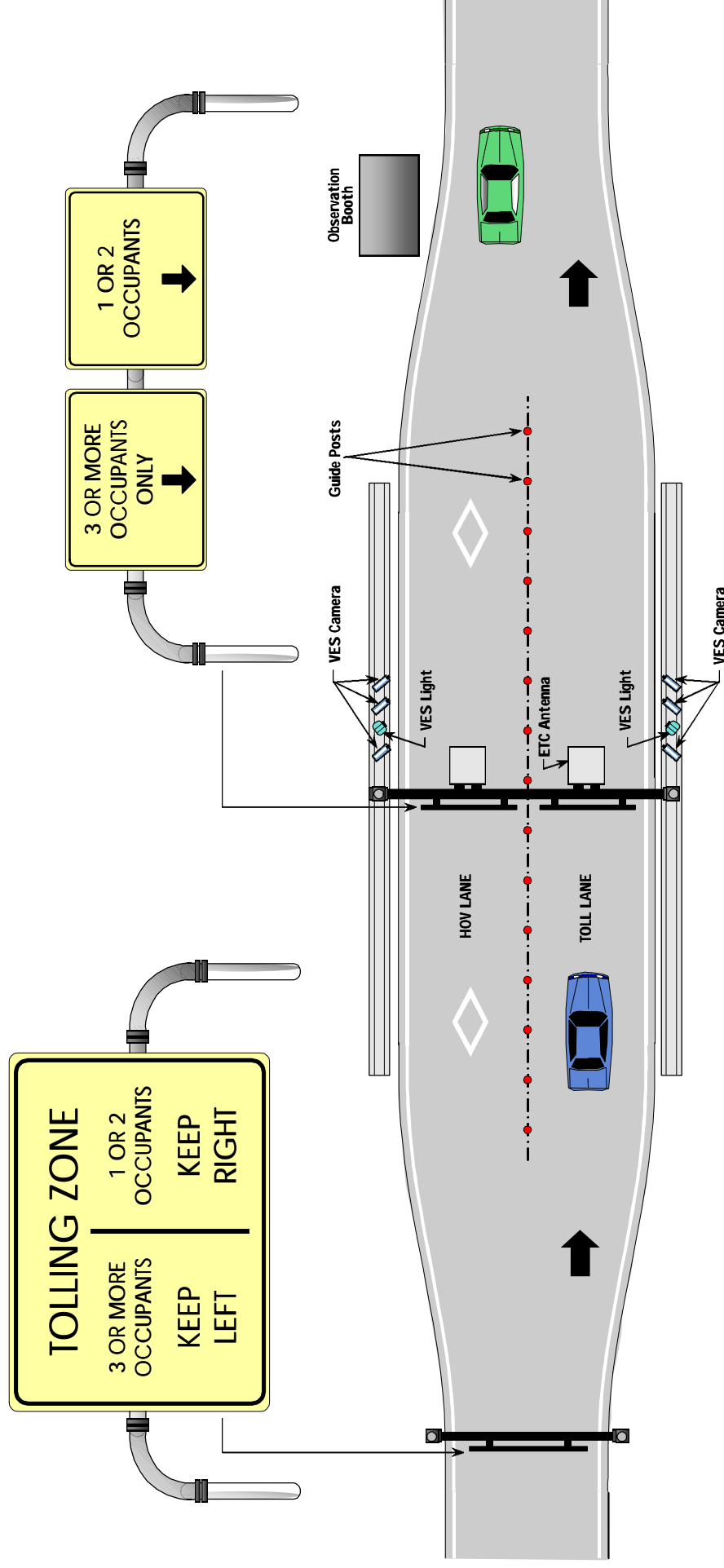
When the vehicle subsequently exited the system, another reader would be intercepted. This would read the information from the exit transaction off the transponder and determine the appropriate toll charge. Since the vehicle occupancy level would have been delineated at the point of entry, it would not be necessary to have two-lane segregation on the exit ramps.

An exception to this would be if decisions were reached to allow HOV traffic to use the managed lanes without any transponder at all. In this case, separate HOV bypass lanes would be required on all entry **and** exit points; with HOV compliance being visually monitored on a periodic basis.

Figure 5-5 shows the typical split-lane ramp tolling zone where the single-lane ramp is widened to two lanes for a short distance to allow for the delineation of HOV and SOV traffic. An observation booth would also be included to insure adequate monitoring of HOV compliance. Only vehicles with three or more occupants (assuming HOV-3+ definition) would be permitted to use the HOV lane. All other traffic would use the toll lane. Depending on which lane the vehicle used, the system would write the appropriate occupancy classification on the tag without the need for any action on the part of the motorist. A typical tolling zone would also include violation enforcement system (VES), cameras and lighting that could be sidemounted at locations where no more than two toll lanes were involved.

Figure 5-6 shows a single lane entry/exit ramp. This would be typical of exit locations, if a read-write transponder approach was used, as described above. It could also be used in a system where there was no automatic segregation between HOV and non-HOV traffic. Under this approach, the HOV vehicle transponder would be temporarily disabled, possibly through the use of smart card procedures. No tolls would be charged to the vehicle, however, a light of some type mounted near the reader would go on for each vehicle for which a valid electronic toll transponder was not read. Enforcement would be limited to visual observation; hence, the enforcement officer would be looking for either three occupants or a valid toll transaction, as indicated by the VES light. A system similar to this is now in use on I-15 Managed Lanes project in San Diego.

It should be noted if no channelization is provided on either entry or exit, enforcement would be limited primarily to visual enforcement of HOV regulation. Toll enforcement will become much more complex; which could affect the financability of the project.



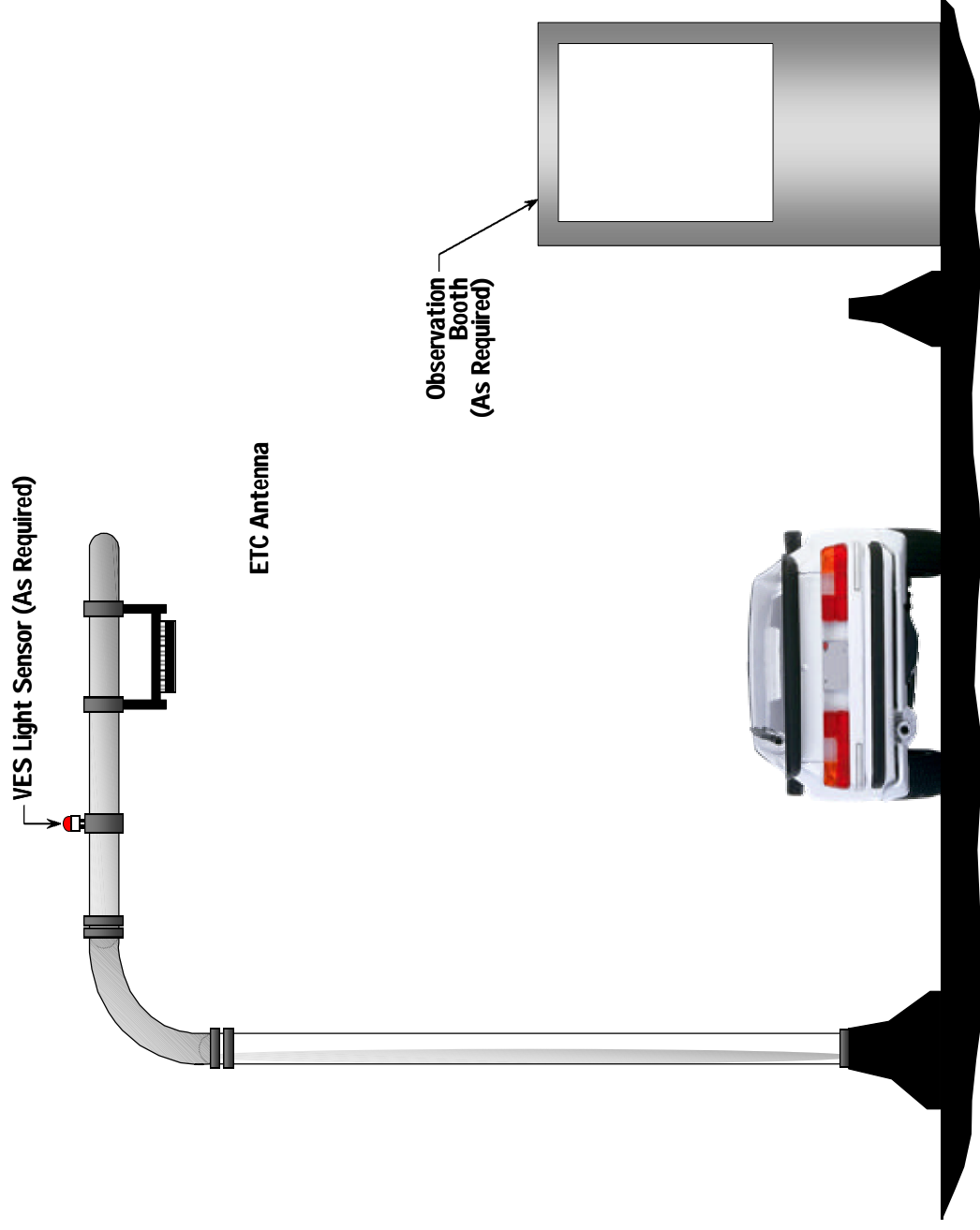


Figure 5-7 shows a typical mainline tolling zone for the west end of the project. This is where eastbound traffic would first enter the managed lanes and would be segregated into HOV and non-HOV components. Traffic exiting at that location would not need to be segregated, unless HOV traffic was allowed to use the managed lanes without transponders.

Figure 5-8 shows the typical mainline tolling zone for the reversible roadway section. Here two gantries are provided, each equipped with VES and ETC equipment to cover each travel direction. A two-lane reversible roadway would be widened to three lanes for a short distance, allowing the third lane being provided for HOV traffic to ensure it would not be tolled.

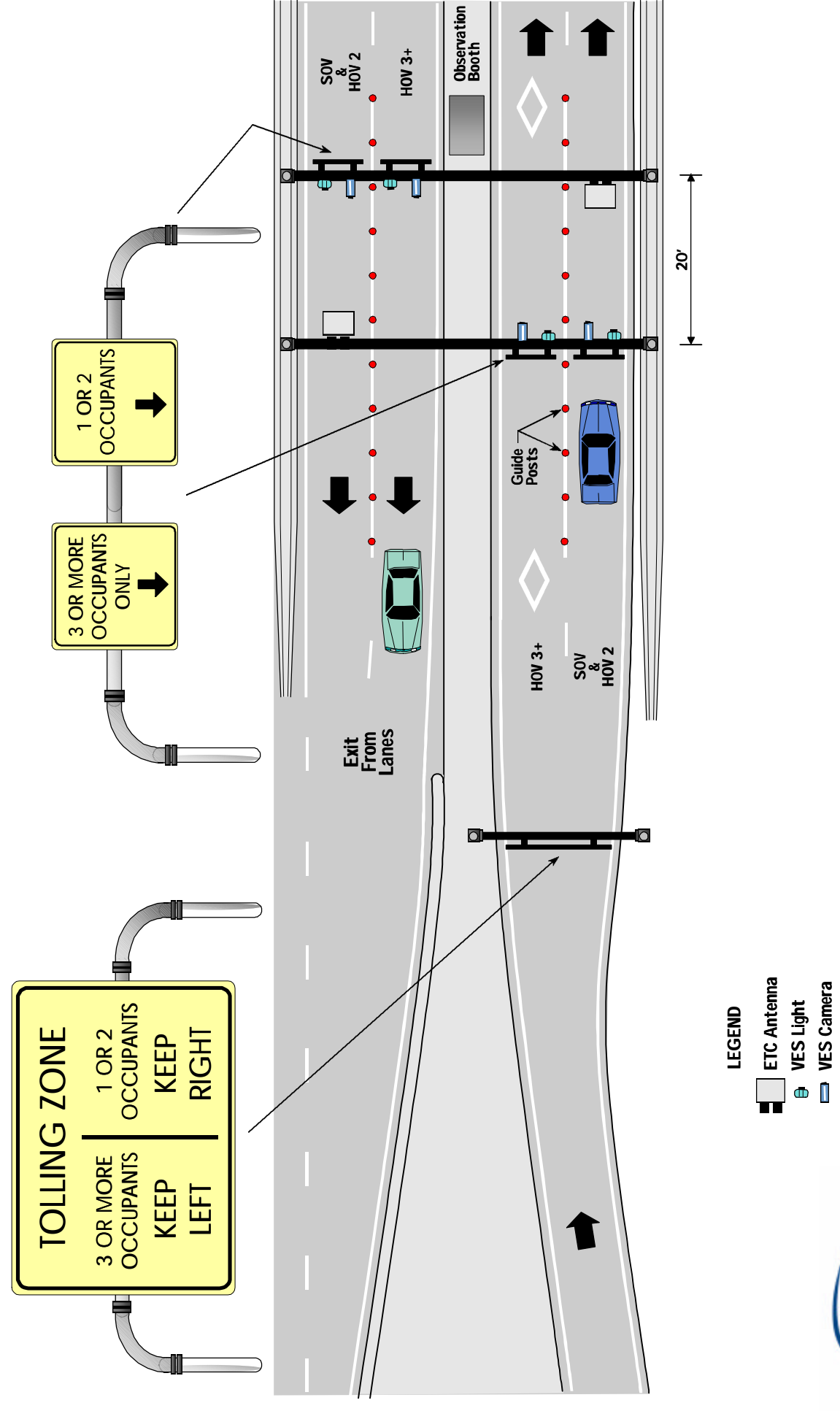
PREFERRED APPROACH

The entry-exit closed system approach would have a number of advantages over the multiple gantry system in Alternative 1. It would greatly simplify all aspects of dynamic pricing and would ensure that the same per-mile rate would be charged to a given motorist since the toll rate in affect at the time the vehicle entered the managed lane would be written on the transponder or smart card. It would permit a more efficient handling of minimum and maximum tolls, since each trip would ultimately be a single point-to-point transaction. Finally, it would provide much better data in terms of travel patterns on the managed lanes and more complete information for patron accounting purposes.

The biggest disadvantage would be the possible requirement for widening the entry ramp for short distances to accommodate HOV and non-HOV delineation. If this is possible, this would be a preferred approach, so as to substantially improve enforceability and auditability and automation of the toll collection process. It would still be possible to do a closed system without segregating HOV and non-HOV traffic on entry, but this would have significant operational and audit disadvantages.

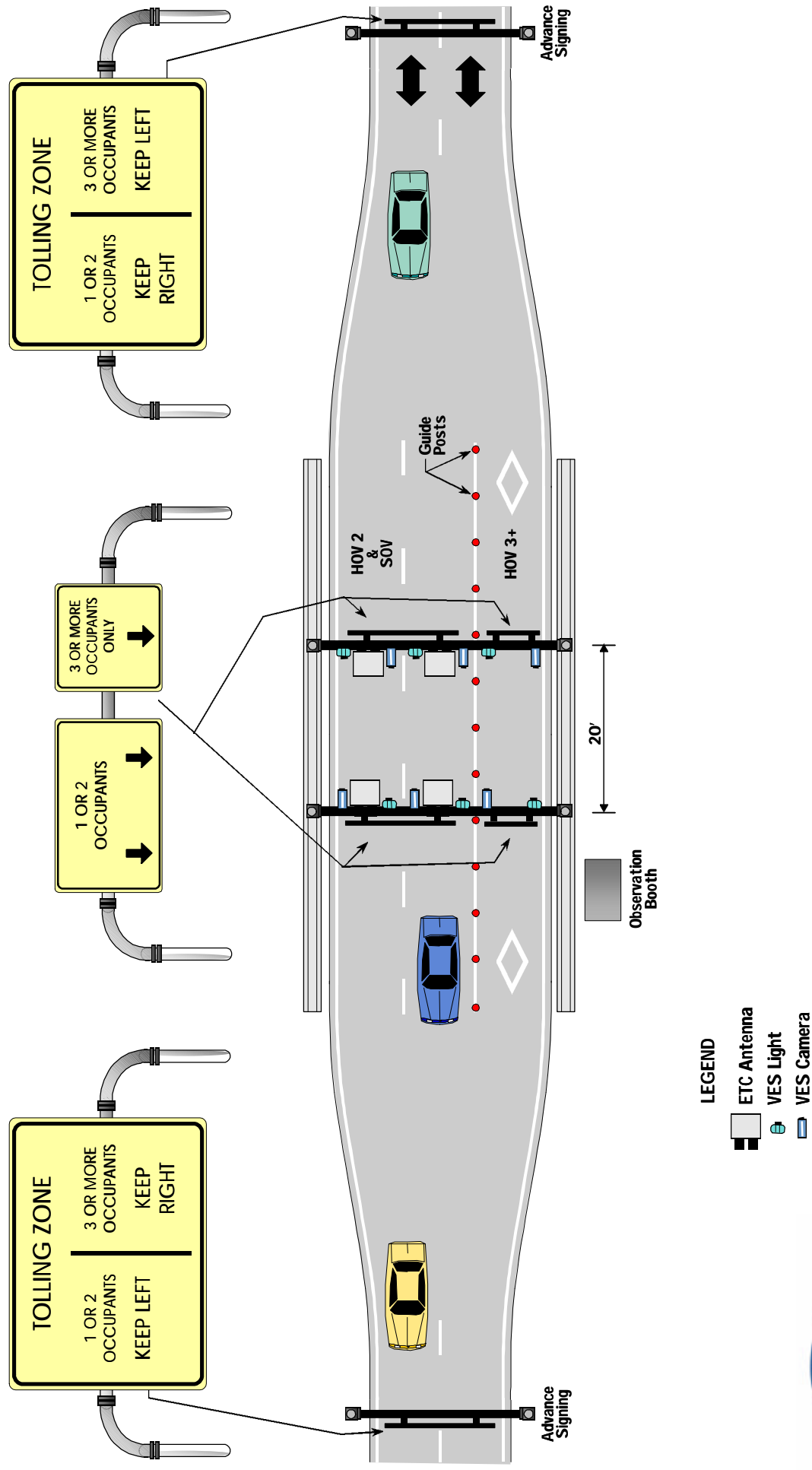
VEHICLE CLASSIFICATION SYSTEMS

While not evaluated in detail in this study, the possibility exists that the managed lanes might be made available to light and/or heavy trucks, along with cars. If trucks were to be assessed the same toll rates as passenger cars, it would not be necessary to have an automated classification system. However, if trucks were charged a different rate than cars, as is typically done in most other toll facilities, the automated toll collection system would require the addition of automatic vehicle classification (AVC) to the various components described above.



WEST END MAINLINE TOLLING ZONE

FIGURE 5-7



TYPICAL ML TOLLING ZONE - REVERSIBLE ROADWAY

FIGURE 5-8

AVC can be accomplished relatively easy if the toll structure itself is relatively simple. For example, the Highway 407 fully electronic toll system in Toronto uses a “three-classification structure;” essentially passenger cars and other light vehicles, single-unit trucks and multi-unit trucks. This level of vehicle classification can be automatically performed easily by readily available laser profiling systems which can simply be added to the gantries along with the electronic tolls and VES systems.

In short, the introduction of commercial vehicles to the traffic stream would not present a substantial additional challenge to the ETC system, but would require additional components and additional capital cost for implementation.

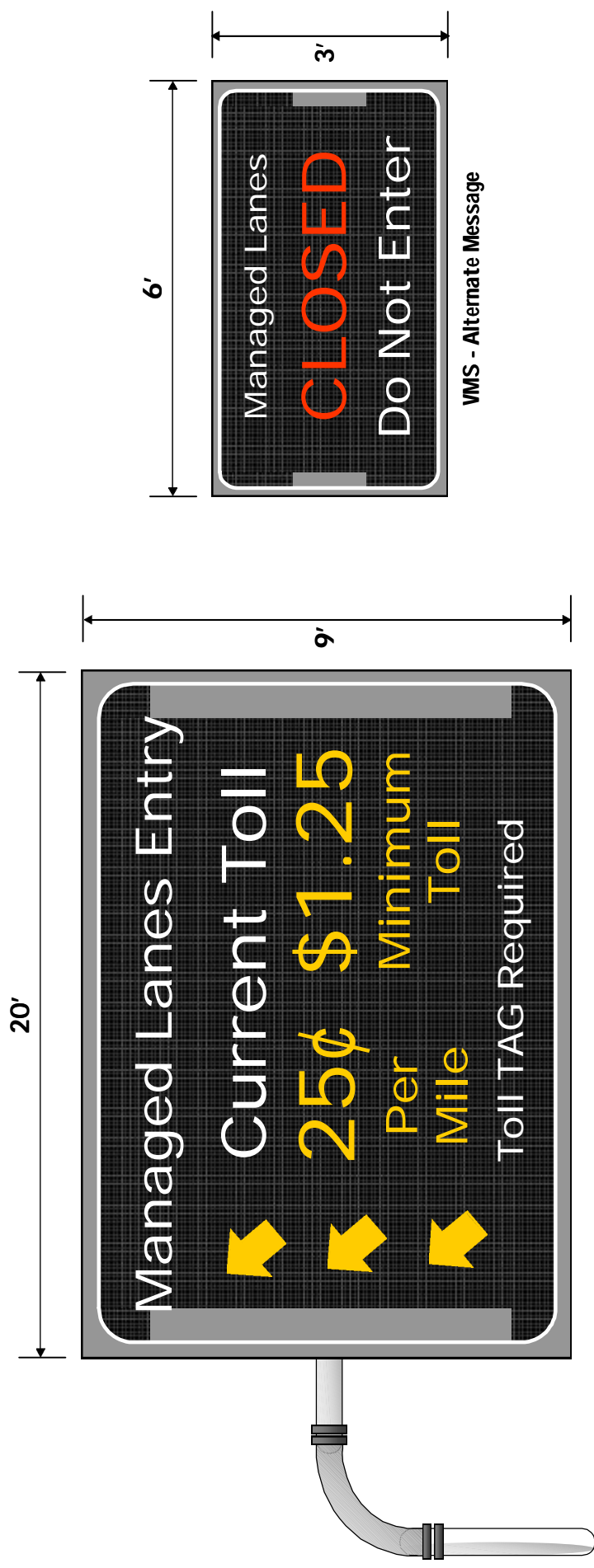
MOTORIST INFORMATION SYSTEMS

It is important to recognize the need to communicate the toll rates in affect at any given time to motorists before they choose to enter the managed lanes roadway. In the case of S.R. 91 and I-15, this is relatively easy to do since both of these facilities have essentially a single entry and exit point at each end and all vehicles using the road at any given time pay the same rate.

The LBJML facility pricing would likely be mileage-based and probably dynamic in nature, that is changing frequently. Since it will not be practical to show the toll rate at every entry point, for all potential exit points, on a variable message sign, a more simplistic approach is needed.

Figure 5-9 shows a typical variable message sign which would be located near each of the entry points. One concept would be to simply show the prevailing “per-mile” toll rate at any given time, together with the current “minimum toll” if any. The same variable message sign could also be used to show when the lanes are closed on the reversible lane section, for example.

The variable message tolling signs would need to be fully integrated with the electronic toll system to ensure that the rate each motorist was charged was equal to the rate displayed at the time the vehicle entered. This is one of the key advantages of using the proposed entry/exit toll system. In the absence of this, it would be necessary to have some type of “time-offset allowance” to ensure no overcharging; this would potentially have a negative impact on revenue and could prove to be difficult during times of high congestion or incidents within the MLs.



INTERMODAL PRICING OPPORTUNITIES AND OTHER USES

A key feature of the MLs is several direct connections between the lanes and transit centers. In total, direct or indirect access is provided to at least four possible intermodal transfer points, two which will feature light rail connections and two which would feature park and ride/express bus operation. Depending on the ultimate toll collection system used, it might be possible to design the system to recognize intermodal transfers and incorporate these into pricing strategies.

For example, it might be possible to allow for reduced rate travel in the MLs for vehicles entering a transit park-and-ride facility immediately following use of the MLs. This could provide a further incentive for modal transfer and further enhance the demand “management” capability of the managed lane.

Integrated electronic fare collection would be greatly enhanced through the use of smart cards. By the time the MLs open to traffic, it is not unlikely that smart card use, including an electronic toll application, is much more commonplace.

Other likely uses for smart cards include administrative functions related to commercial vehicle operations. Most significantly to this market are the border area inspections and the reduced processing time potentially available through the utilization of smart cards as part of monitoring and inspection record keeping process. In order to minimize the number of such cards commercial drivers would be required to carry, steps should be taken now within the planning processes of the various state and federal agencies designing their individual smart cards to insure interoperability for a variety of market and administrative uses.

ETC PROCESSING

Current ETC processing is accomplished by each motorist desiring to use the toll facility establishing an account with the toll agency. Each time the facility is used, the toll is subtracted from the customers account balance. When the account balance reaches a pre-determined low level, it is increased by a pre-set amount by the method selected by the customer (credit card, debit card, cash, etc.).

This method is expensive and frequently requires customers to have an account with more than one agency. Even when a single account is used for multiple agencies, the cumbersome task of distributing valid

transponder numbers to each agency in a real time environment is expensive.

The use of “smart card” technology may offer a better solution. Existing financial institutions can provide the transfer of funds to a “smart card” issued by the institution. The “smart card” can be inserted into a transponder when using a toll road and the fee subtracted from the card balance. Each time a fee is subtracted from a card, the trip data and fee are transmitted to the toll agency in use. The agency then request a transfer from the financial institution, on either a transaction-by-transaction basis or a summary basis, and the transaction is complete.

Using this technique, the transponders and antennae used must be interoperable between agencies. However, the “smart card” status determines the transponder status and the need to exchange data between agencies is eliminated.

Gathering statistical data on toll road use is important to each agency. The trip data gathered to determine the toll could be retained and reports could be generated to meet the needs of the individual agencies.

The “smart card” could also be efficiently used for other transportation modes. Inexpensive readers could be mounted in buses and trains or the card could be used to pre-pay for trips (tickets). Parking facilities could mount inexpensive readers that could use the card to pay for time in a parking facility or antennae could be installed to make the entire process automated (similar to a toll road). In all cases, the customer controls the value of the card and the conventional ETC back office processing is reduced to statistical reporting and violation processing.

The use of “smart cards” for transportation fee collection is an emerging technology in the United States. Since the completion date of this project is beyond what can reasonably be predicted in technology development, it will be critical that these issues are revisited over the life of the project. Approximately five years prior to implementation, the methodology for fee collection will have to be finalized. This is due to the lead time to secure technologies recognized that are in the planning and development stage to come to the market.

APPENDIX A

Appendix 1

TRAFFIC COUNT LOCATIONS

Ramp/Frontage Road ATR Locations (48-Continuous Hours)

- 1 WB IH-635 off to Denton Drive
- 2 EB IH-635 on from Denton Drive
- 3 EB IH-635 on from Josey Lane
- 4 EB IH-635 off to Josey Lane
- 5 WB IH-635 on from West of Webb Chapel Road
- 6 EB IH-635 off to Webb Chapel Road
- 7 WB IH-635 on from East of Webb Chapel Road
- 8 EB IH-635 on from Webb Chapel Road
- 9 WB IH-635 off to Webb Chapel Road
- 10 EB IH-635 off to Marsh Lane
- 11 WB IH-635 off to Marsh Lane
- 12 EB IH-635 on from Marsh Lane
- 13 WB IH-635 on from West of Dallas North Tollway
- 14 EB IH-635 off to West of Dallas North Tollway
- 15 WB IH-635 off to Noel
- 16 EB IH-635 on from West of Montfort Drive
- 17 WB IH-635 on from West of Preston Road
- 18 EB IH-635 off to Preston Road
- 19 WB IH-635 off to Montfort Drive
- 20 EB IH-635 on from West of Preston Road
- 21 WB IH-635 on from Hillcrest Road
- 22 EB IH-635 off to Hillcrest Road
- 23 WB IH-635 off to Preston Road
- 24 EB IH-635 on from West of Hillcrest Road
- 25 WB IH-635 off to Hillcrest Road
- 26 EB IH-635 on from East of Hillcrest Road
- 27 WB IH-635 on from Coit Road
- 28 EB IH-635 off to Coit Road
- 29 WB IH-635 off to Coit Road
- 30 EB IH-635 off to SB US-75
- 31 SB US-75 off to WB IH-635
- 32 WB IH-635 off to SB US-75
- 33 EB IH-635 off to NB US-75
- 34 NB US-75 off to EB IH-635
- 35 WB IH-635 on from TI Blvd.
- 36 EB IH-635 off to TI Blvd.
- 37 WB IH-635 on from TI Blvd.
- 38 EB IH-635 on from TI Blvd.

Appendix A (continued)

| | |
|-----|---|
| 39 | WB IH-635 on from Greenville Ave |
| 40 | EB IH-635 off to Greenville Ave |
| 41 | WB IH-635 on from East of Greenville Ave |
| 42 | EB IH-635 off to Forest Lane |
| 43 | WB IH-635 off to Greenville Ave |
| 44 | EB IH-635 on from Forest Lane |
| 45 | WB IH-635 off to Forest Lane |
| 46 | EB IH-635 on from Forest Lane |
| 47 | WB IH-635 on from Royal Lane |
| 48 | EB IH-635 off to Plano Road |
| 49 | WB IH-635 on from Plano Road |
| 50 | EB IH-635 on from Plano Road |
| 51 | WB IH-635 off to Plano Road |
| 52 | EB IH-635 off to Kingsley Road |
| 53 | WB IH-635 on from Jupiter Road |
| 53A | EB IH-635 on from Jupiter Road |
| 54 | EB IH-635 off to Garland Ave |
| 55 | WB IH-635 on from Garland Ave |
| 56 | EB IH-635 off to Ferguson Road |
| 57 | NB IH-635 on from Centerville Road |
| 58 | EB IH-635 on from Ferguson Road |
| 59 | WB IH-635 off to Centerville Road |
| 60 | EB IH-635 off to La Prada Drive |
| 61 | NB IH-635 on from La Prada Drive |
| 62 | SB IH-635 off to Oates Drive |
| 63 | NB IH-635 on from Oates Drive |
| 64 | SB IH-635 on from Oates Drive |
| 65 | NB IH-635 off to Oates Drive |
| 66 | WB IH-635 Frontage Road West of Welch Road (Sunday and Monday Counts) |
| 67 | EB IH-635 Frontage Road West of Welch Road (Sunday and Monday Counts) |
| 70 | SB US-75 off to EB IH-635 |
| 71 | NB US-75 off to WB IH-635 |
| 72 | SB Dallas North Tollway off to EB IH-635 |
| 73 | NB Dallas North Tollway off to EB IH-635 |
| 74 | NB Dallas North Tollway off to WB IH-635 |
| 75 | WB IH-635 off to NB IH-35E |
| 76 | WB IH-635 off to SB IH-35E |
| 77 | EB IH-30 off to SB IH-635 |
| 100 | Brookhaven Club West of Marsh Lane |
| 101 | Valley View Lane West of Marsh Lane |
| 102 | Forest Lane West of Marsh Lane |
| 103 | Northhaven Road West of Marsh Lane |
| 104 | Spring Valley Road East of Montfort Drive |

Appendix A (continued)

- 105 Alpha East of Montfort Drive
- 106 Forest East of Dallas North Tollway
- 107 Northhaven Road East of Dallas North Tollway
- 108 Walnut Road East of Abrams Road
- 109 Forest Lane East of Abrams Road
- 110 Royal Lane East of Abrams Road
- 111 Northwest Drive South of Oates Road
- 112 Gus Thomasson Road South of Oates Road

Ramp/Frontage Road ATR Locations (7-Day Continuous Hours)

- 1 WB IH-635 on from Midway Road
- 2 EB IH-635 off to Midway Road
- 3 WB IH-635 off to Midway Road
- 4 EB IH-635 on from Midway Road
- 5 SB Dallas North Tollway to WB IH-635
- 6 WB IH-635 to SB Dallas North Tollway
- 7 WB IH-635 to NB Dallas North Tollway
- 8 EB IH-635 to SB Dallas North Tollway
- 9 EB IH-635 to NB Dallas North Tollway
- 10 WB IH-635 on from Skillman Street
- 11 EB IH-635 off to Skillman Street
- 12 WB IH-635 off to Skillman Street
- 13 EB IH-635 on from Skillman Street
- 14 WB IH-635 on from Northwest Highway
- 15 EB IH-635 off to Northwest Highway
- 16 WB IH-635 off to Northwest Highway
- 17 EB IH-635 on from Northwest Highway
- 18 WB IH-30 to NB IH-635
- 19 SB IH-635 to EB IH-30
- 20 SB IH-635 to WB IH-30
- 21 NB IH-635 to WB IH-30
- 22 WB IH-30 to SB IH-635
- 23 WB IH-635 Frontage Road East of Josey Lane
- 24 EB IH-635 Frontage Road East of Josey Lane
- 25 WB IH-635 Frontage Road East of Hillcrest Road
- 26 EB IH-635 Frontage Road East of Hillcrest Road

Appendix A (continued)

Intersection Manual Count Locations

(6:00 a.m. – 9:00 a.m.) and (3:00 p.m.-7:00 p.m.)

- 1 WB IH-635 Frontage Road and Harry Hines
- 2 Harry Hines Blvd. and Forest Lane
- 3 Denton Drive and Forest Lane
- 4 WB IH-635 Frontage Road and Josey Lane
- 5 EB IH-635 Frontage Road and Josey Lane
- 6 Josey Lane and Forest Lane
- 7 WB IH-635 Frontage Road and Webb Chapel Road
- 8 EB IH-635 Frontage Road and Webb Chapel Road
- 9 Forest Lane and Webb Chapel Road
- 10 WB IH-635 Frontage Road and Marsh Lane
- 11 EB IH-635 Frontage Road and Marsh Lane
- 12 Valley View Lane and Alpha Road
- 13 WB IH-635 Frontage Road and Midway Road
- 14 EB IH-635 Frontage Road and Midway Road
- 15 WB IH-635 Frontage Road and Welch Road
- 16 EB IH-635 Frontage Road and Welch Road
- 17 WB IH-635 Frontage Road and Montfort Drive
- 18 EB IH-635 Frontage Road and Montfort Drive
- 19 WB IH-635 Frontage Road and Preston Road
- 20 EB IH-635 Frontage Road and Preston Road
- 21 WB IH-635 Frontage Road and Hillcrest Road
- 22 EB IH-635 Frontage Road and Hillcrest Road
- 23 WB IH-635 Frontage Road and Meandering Way
- 24 WB IH-635 Frontage Road and Coit Road
- 25 EB IH-635 Frontage Road and Coit Road
- 26 WB IH-635 Frontage Road and Greenville Ave
- 27 EB IH-635 Frontage Road and Greenville Ave
- 28 WB IH-635 Frontage Road and Abrams Road
- 29 EB IH-635 Frontage Road and Abrams Road
- 30 NB IH-635 Frontage Road and Forest Lane
- 31 Abrams Road and Forest Lane
- 32 SB IH-635 Frontage Road and Forest Lane
- 33 WB IH-635 Frontage Road and Skillman Street
- 34 EB IH-635 Frontage Road and Skillman Street
- 35 NB IH-635 on ramp at Miller Road
- 35A SB IH-635 exit at Miller Road
- 36 WB IH-635 off at Plano Road
- 37 Plano Road and Church Street
- 38 Kingsley Road and Jupiter Road
- 39 SB IH-635 Frontage Road and Kingsley Road

Appendix A (continued)

- 40 WB IH-635 Frontage Road and Kingsley Road
- 41 EB IH-635 Frontage Road and Jupiter Road
- 42 WB IH-635 Frontage Road and McCree
- 43 S. Garland Ave, Shiloh Road and McCree
- 44 Northwest Hwy and Garland Road
- 45 WB IH-635 on ramp and Garland Road
- 46 EB IH-635 off ramp and Garland Road
- 47 NB IH-635 Frontage Road and Northwest Hwy
- 48 Northwest Hwy and Shiloh Road
- 49 SB IH-635 Frontage Road and Northwest Hwy
- 50 NB IH-635 Frontage Road and Centerville/Saturn
- 51 EB IH-635 Frontage Road and Ferguson Road
- 52 NB IH-635 Frontage Road and La Prada Road
- 53 SB IH-635 Frontage Road and La Prada Road
- 54 NB IH-635 Frontage Road and Oates Drive
- 55 SB IH-635 Frontage Road and Oates Drive
- 56 Galloway Ave and Oates Drive
- 57 NB IH-635 Frontage Road and Galloway Ave
- 58 SB IH-635 Frontage Road and Galloway Ave
- 59 WB IH-635 Frontage Road and Galloway Ave
- 60 EB IH-635 Frontage Road and Galloway Ave

Mainline Manual Count Locations (5:00 a.m. – 9:00 p.m.)

- 1 Marsh Lane
- 2 Montford Drive
- 3 Between Abrams Road and Forest Lane
- 4 La Prada Drive

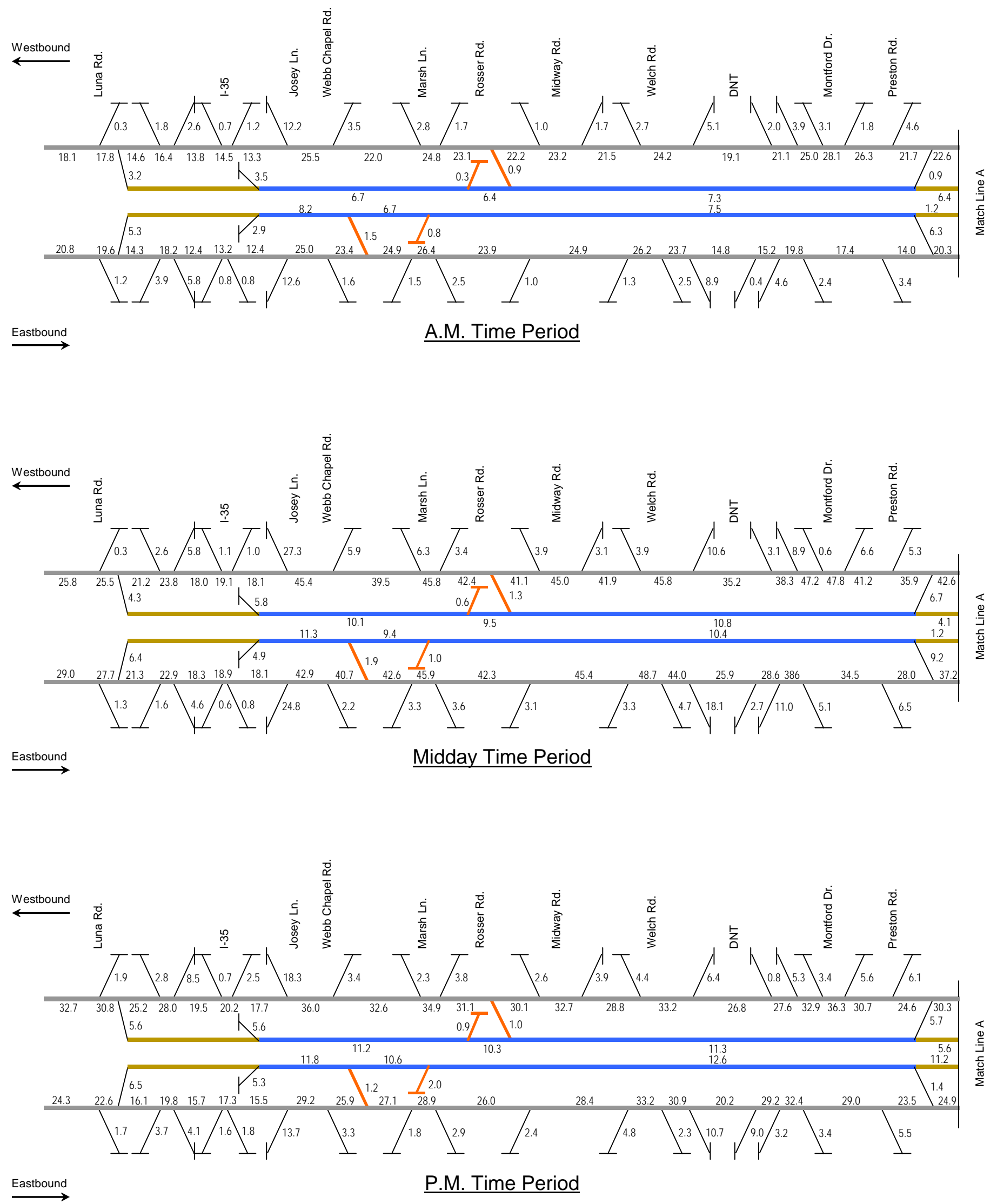
Texas Department of Transportation Provided Count Locations (24-Continuous Hours)

- 1 EB IH-635 on from SB IH-35
- 2 WB IH-635 on from SB IH-35
- 3 WB IH-635 on from NB IH-35
- 4 EB IH-635 off to NB IH-35
- 5 EB IH-635 off to SB IH-35
- 6 EB IH-635 on from NB IH-35
- 7 WB IH-635 at Coit Road
- 8 WB IH-635 off to NB US75

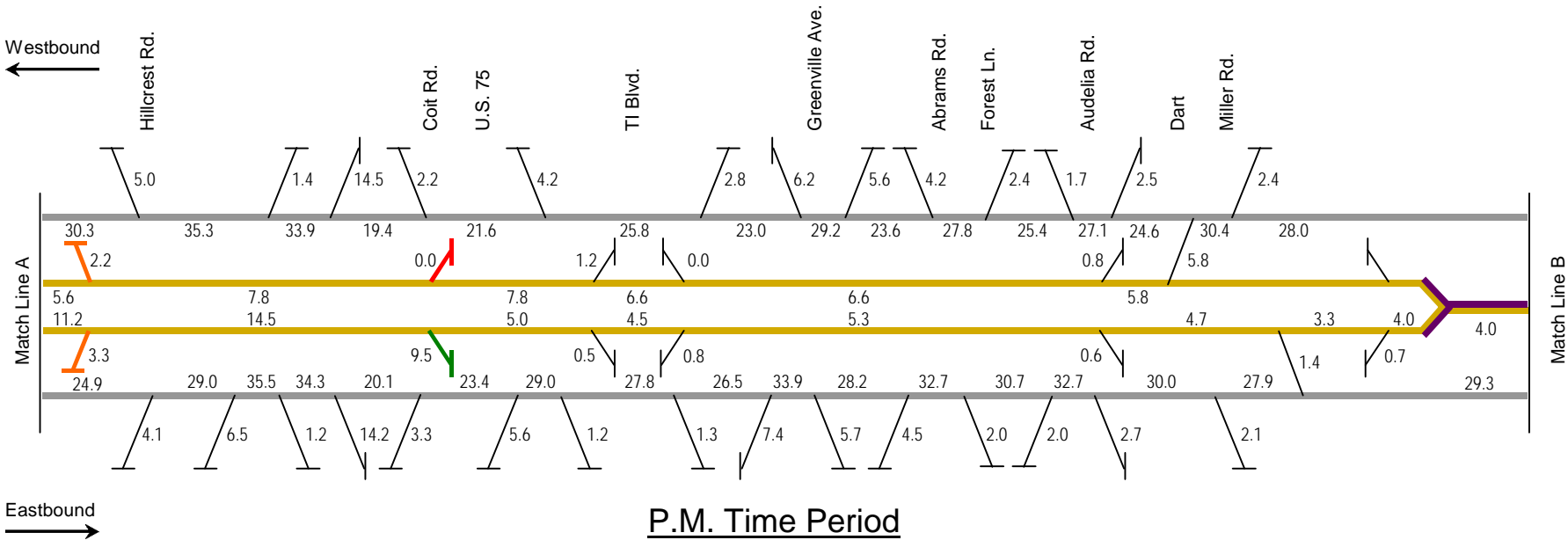
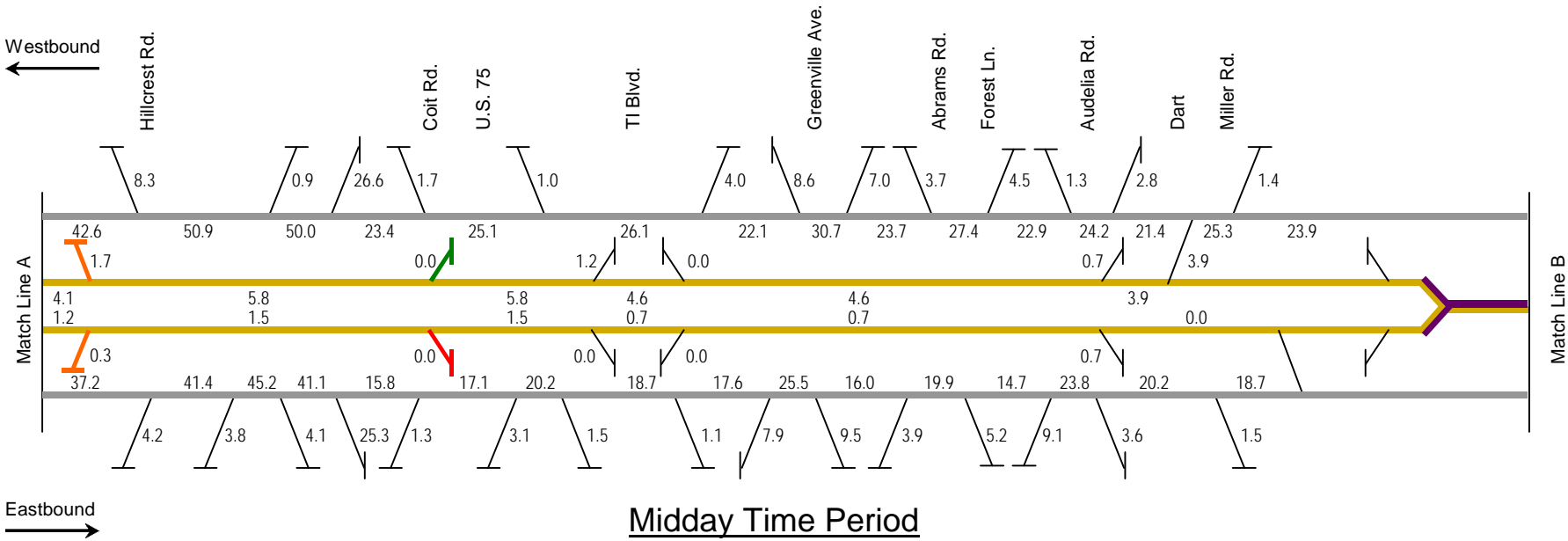
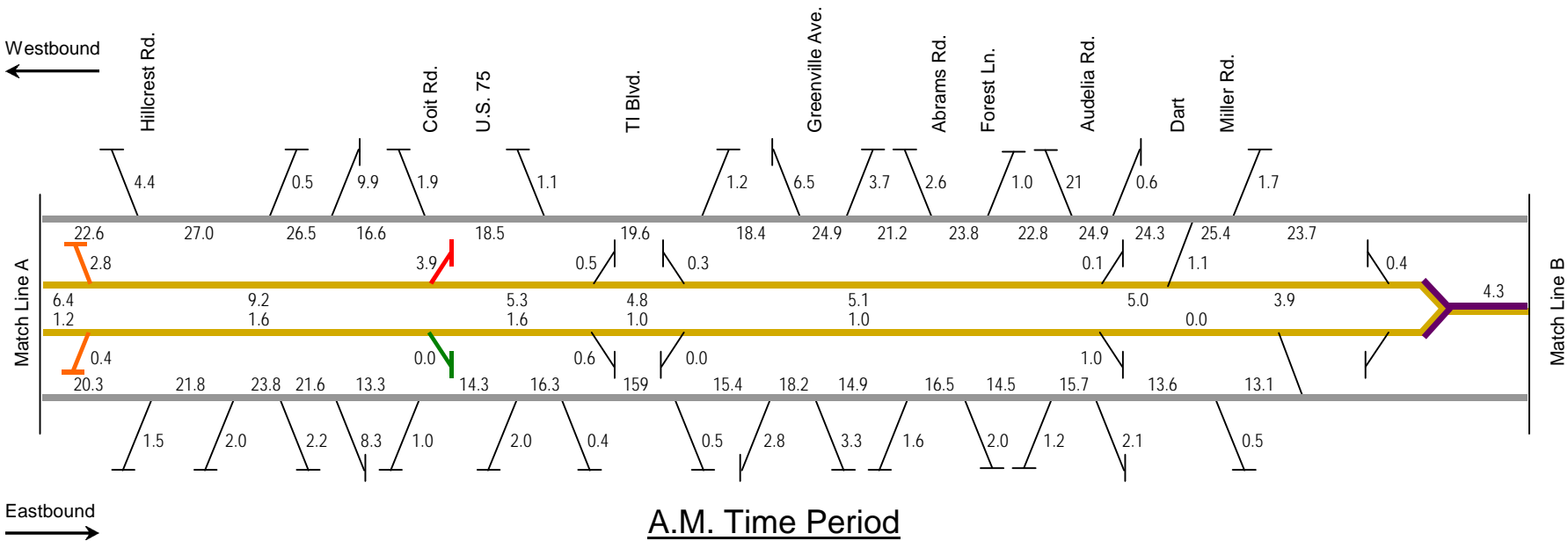
Appendix A (continued)

- 9 WB IH-635 West of Greenville Ave
- 10 EB IH-635 at East of Jupiter Road
- 11 NB IH-635 off to EB IH-30

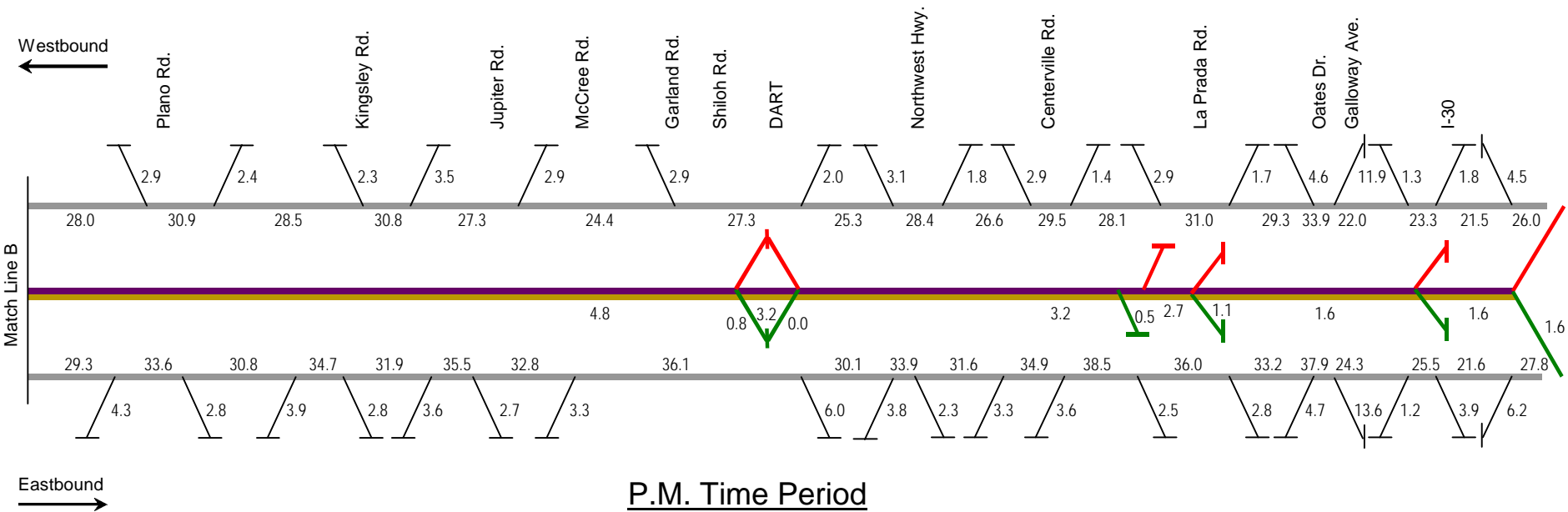
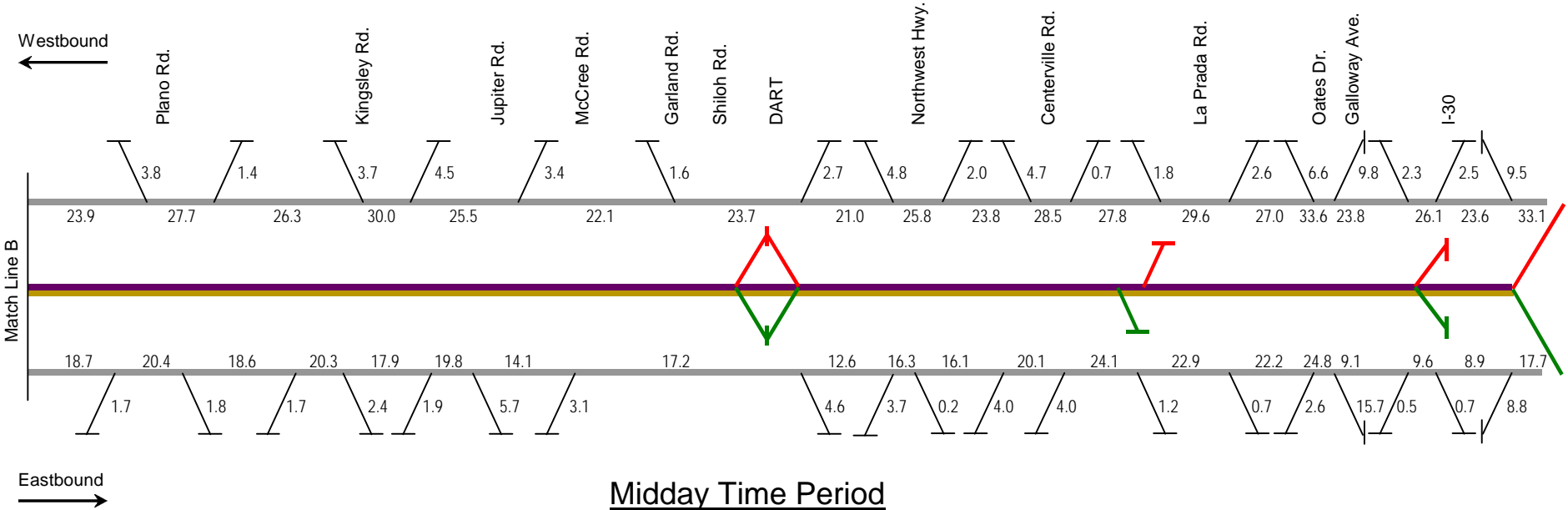
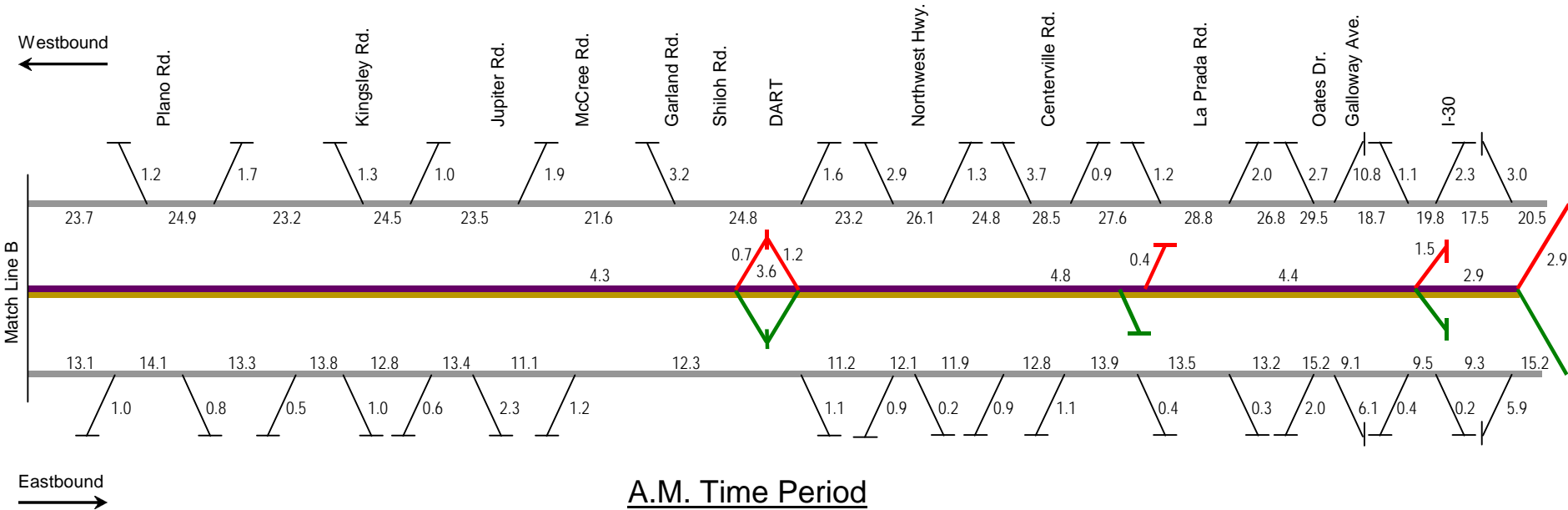
APPENDIX B



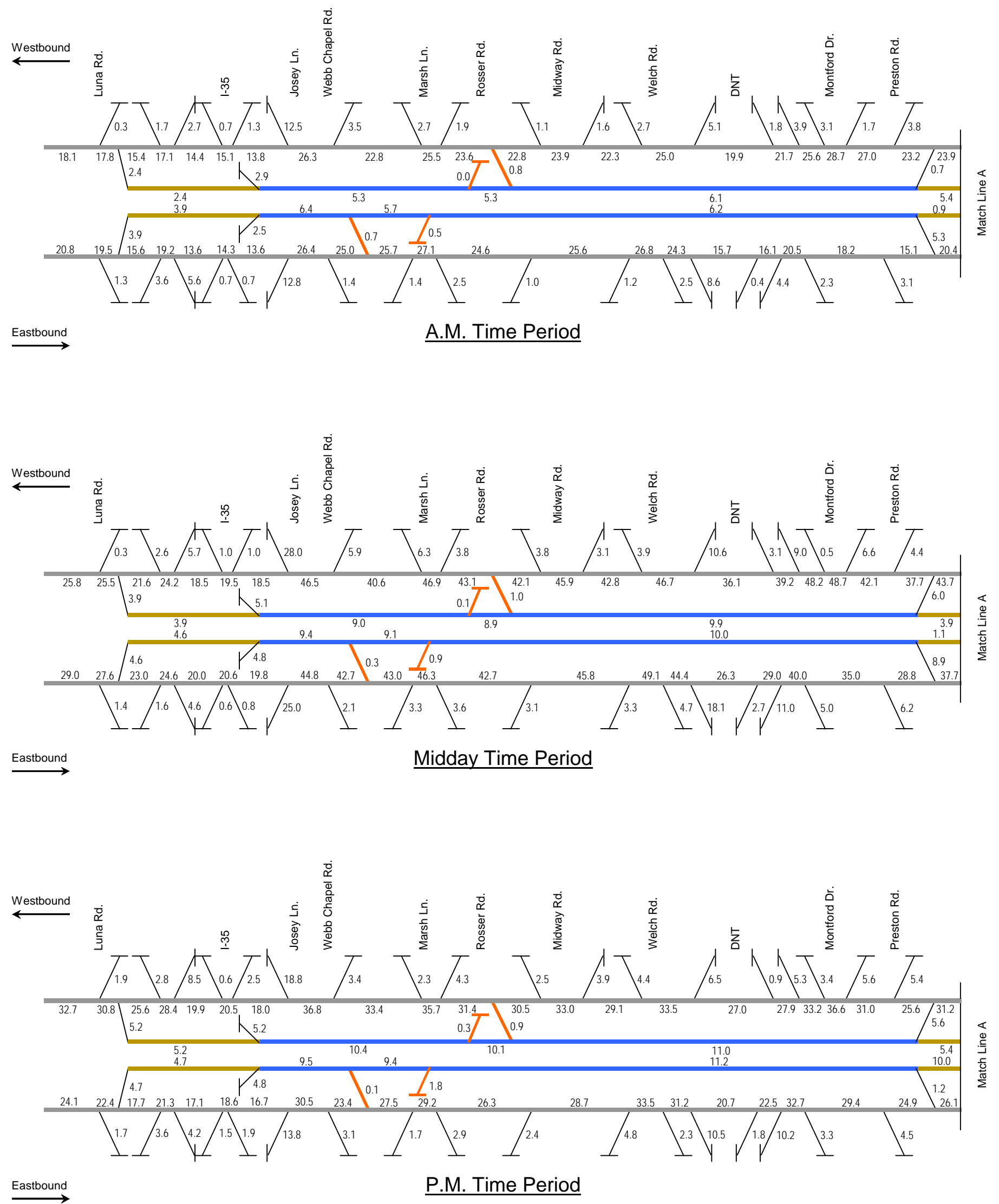
| Managed Lanes | | Legend | | (Volumes in Thousands) |
|-------------------------------------|--|-------------------------------------|---|--|
| — | Three Managed Lanes | — | Does Not Exist in Modified Access | / Westbound Entrance, Eastbound Exit |
| — | Two Managed Lanes | — | General Purpose Lanes | \ Eastbound Entrance, Westbound Exit |
| — | Reversible Lanes | — | Open A.M. Period (6:00am – 9:00am) Only | Frontage Road Connection |
| | Open Westbound A.M. Period (6:00-9:00am) | — | Open P.M. Period (3:00pm - 7:00pm) Only | / Intersection Street / Highway Connection |
| | Open Eastbound P.M. Period (3:00-7:00pm) | | | |



| Managed Lanes | | Legend | | (Volumes in Thousands) |
|--|---------------------|---------------------------------------|---|--|
| — | Three Managed Lanes | — | Does Not Exist in Modified Access | / Westbound Entrance, Eastbound Exit |
| — | Two Managed Lanes | — | General Purpose Lanes | \ Eastbound Entrance, Westbound Exit |
| — | Reversible Lanes | — | Open A.M. Period (6:00am – 9:00am) Only | Frontage Road Connection |
| Open Westbound A.M. Period (6:00-9:00am) | | — | Open P.M. Period (3:00pm - 7:00pm) Only | / Intersection Street / Highway Connection |
| Open Eastbound P.M. Period (3:00-7:00pm) | | | | |



| Managed Lanes | | Legend | | (Volumes in Thousands) |
|---------------------------------------|--|---------------------------------------|---|--|
| — | Three Managed Lanes | — | Does Not Exist in Modified Access | / Westbound Entrance, Eastbound Exit |
| — | Two Managed Lanes | — | General Purpose Lanes | \ Eastbound Entrance, Westbound Exit |
| — | Reversible Lanes | — | Open A.M. Period (6:00am – 9:00am) Only | Frontage Road Connection |
| | Open Westbound A.M. Period (6:00-9:00am) | — | Open P.M. Period (3:00pm - 7:00pm) Only | Intersection Street / Highway Connection |
| | Open Eastbound P.M. Period (3:00-7:00pm) | | | |



Managed Lanes

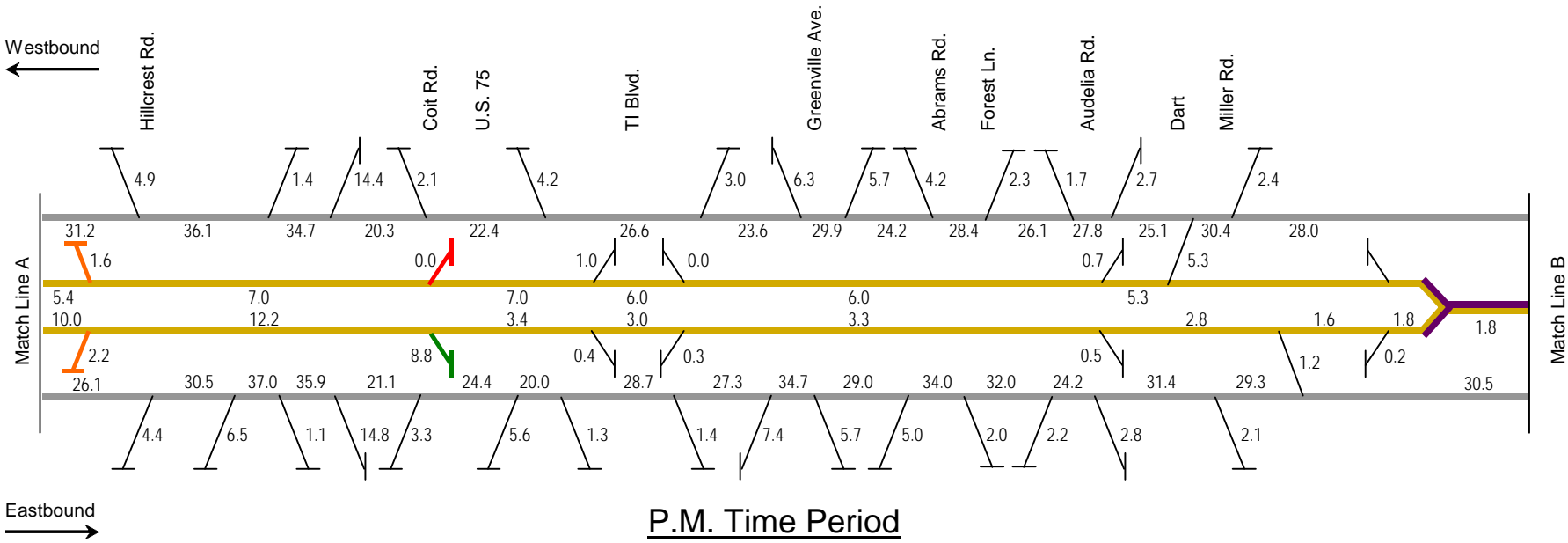
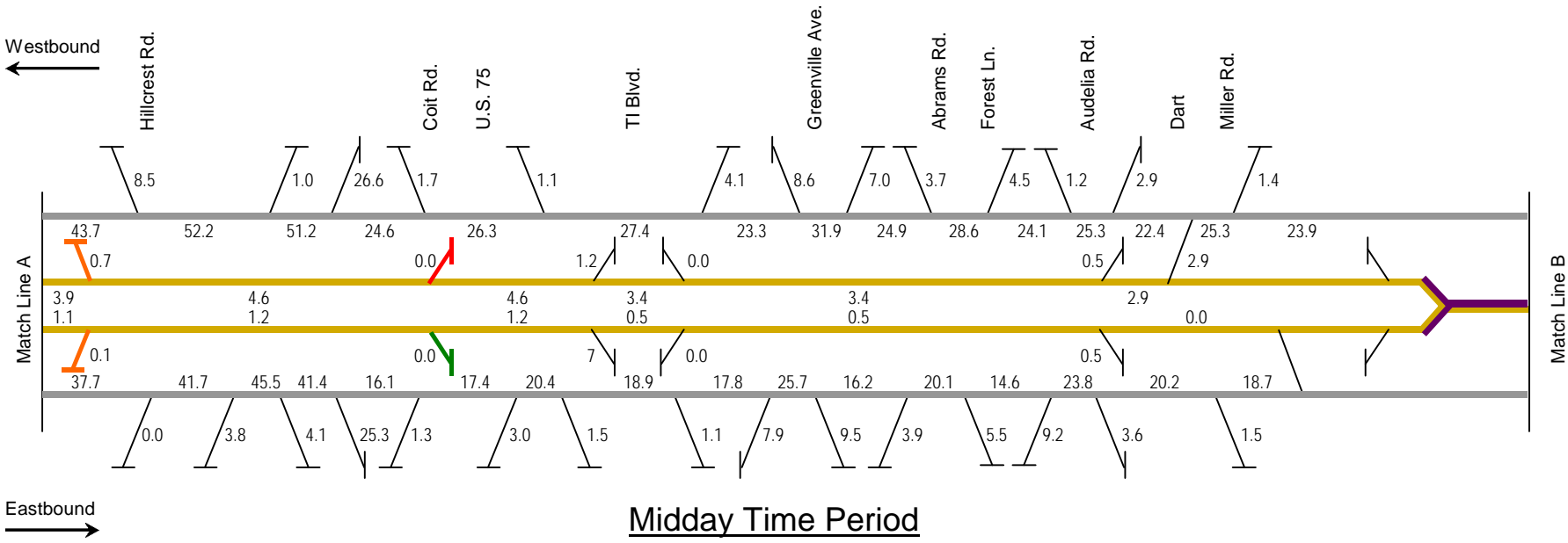
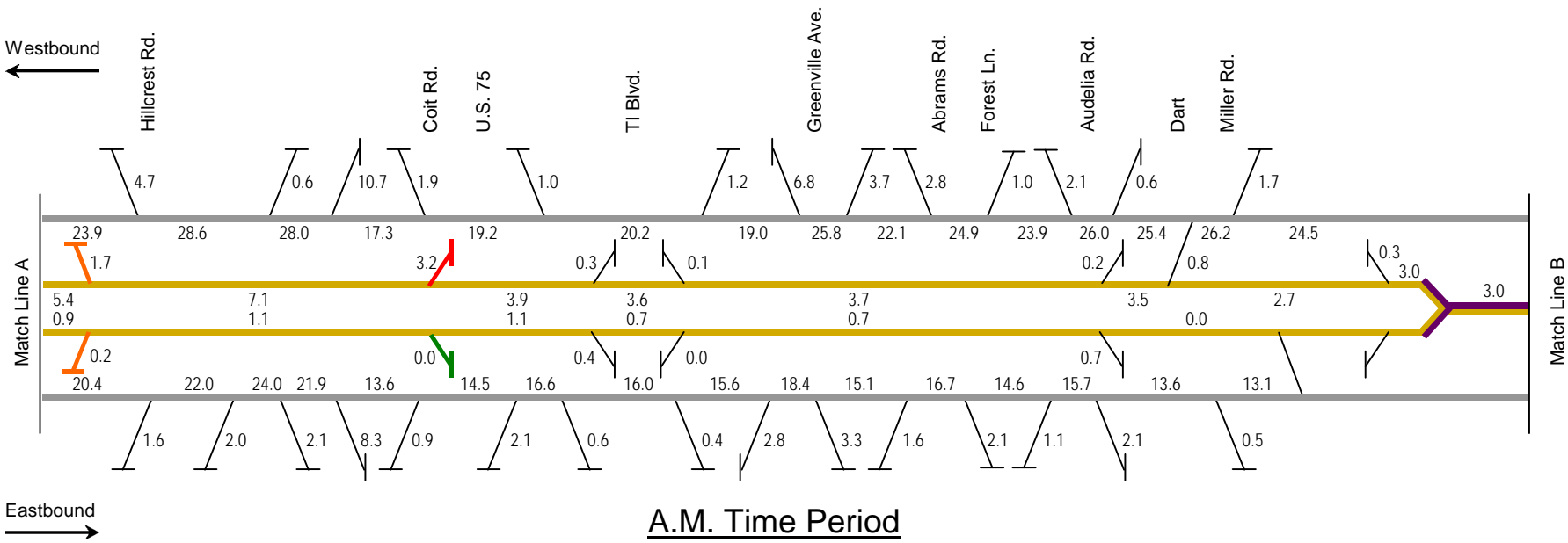
- Three Managed Lanes
- Two Managed Lanes
- Reversible Lanes
Open Westbound A.M. Period (6:00-9:00am)
Open Eastbound P.M. Period (3:00-7:00pm)

Legend

- Does Not Exist in Modified Access
- General Purpose Lanes
- Open A.M. Period (6:00am – 9:00am) Only
- Open P.M. Period (3:00pm - 7:00pm) Only

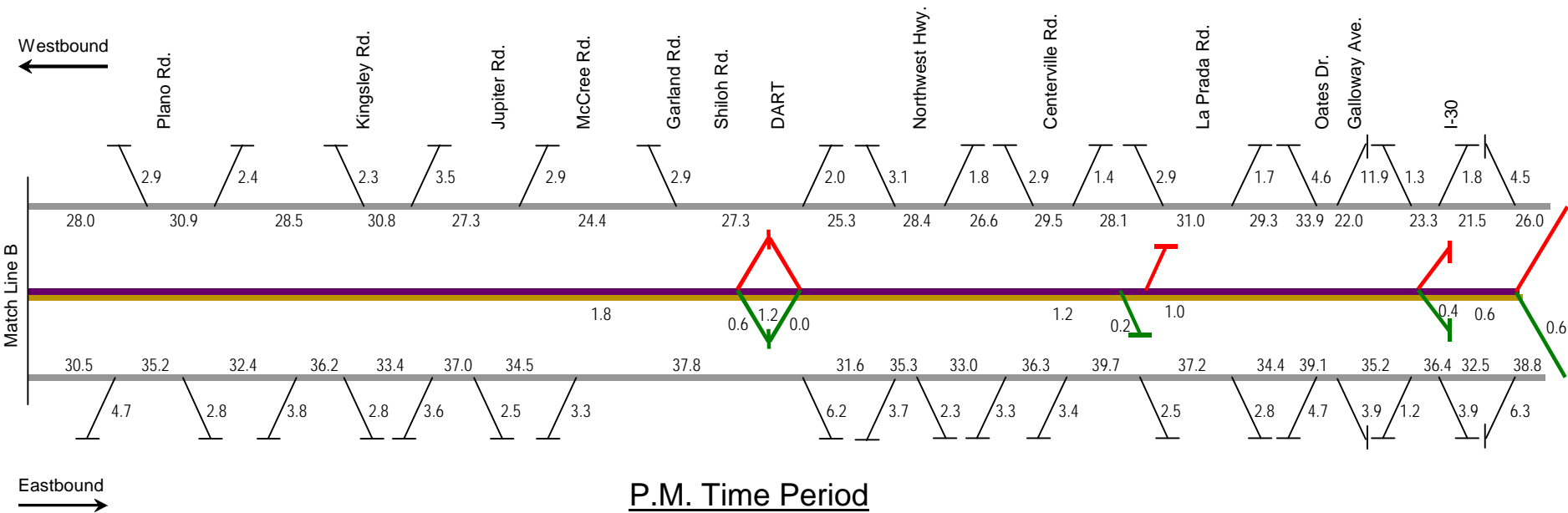
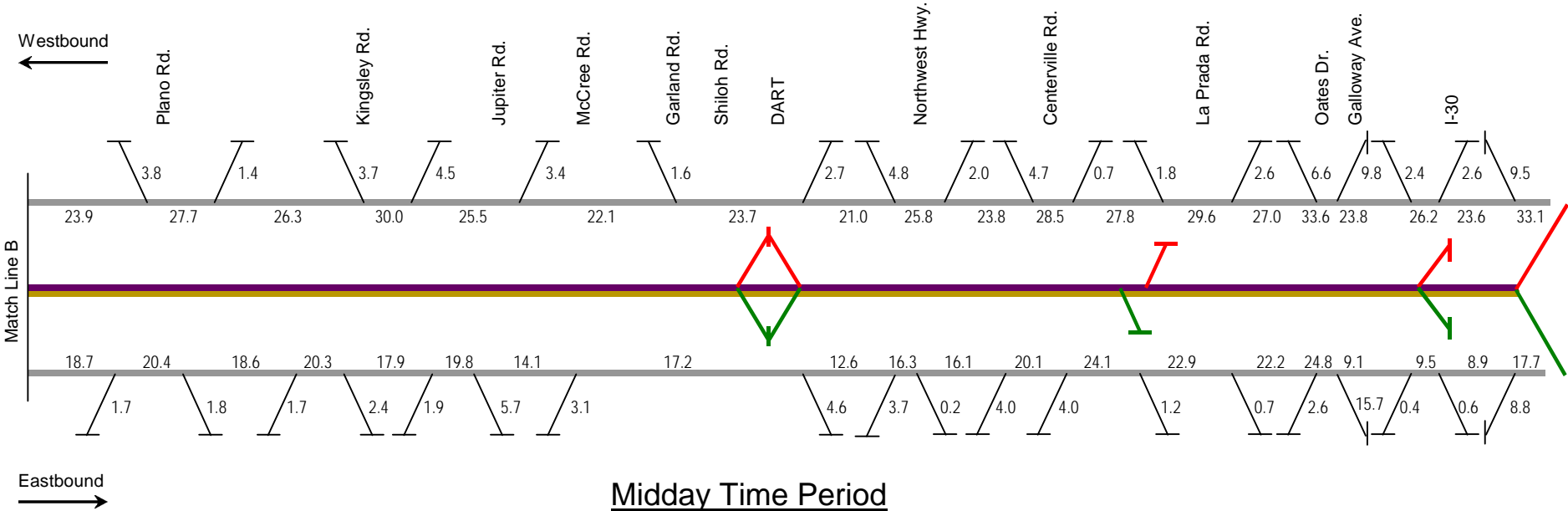
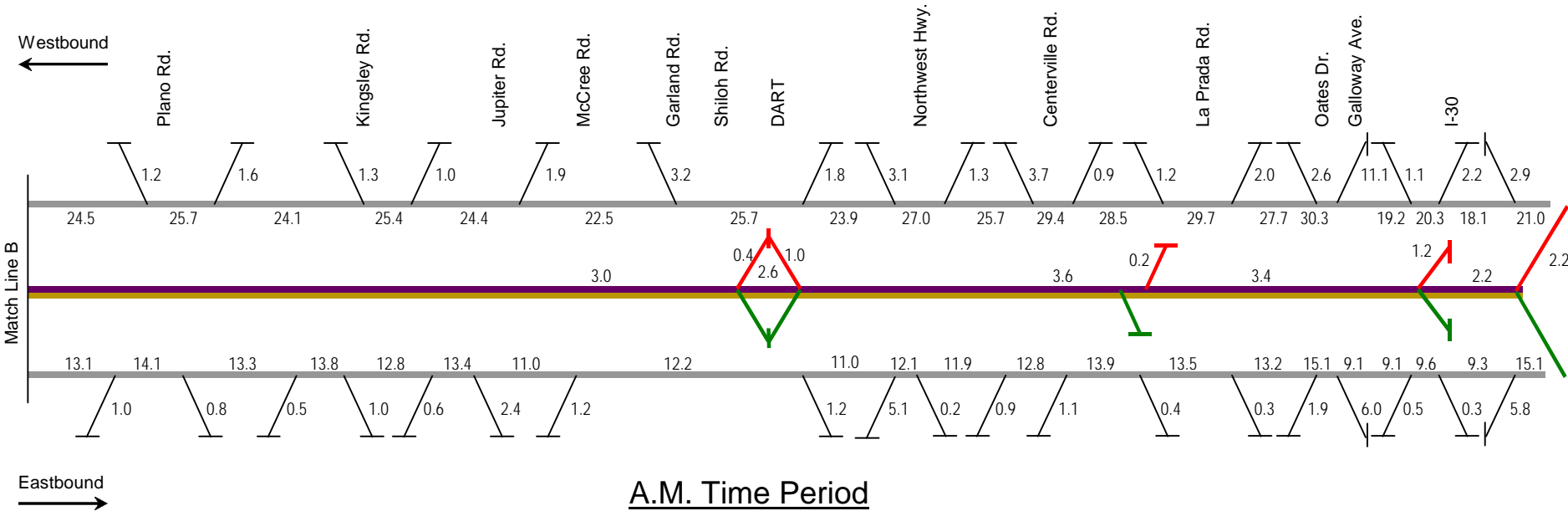
(Volumes in Thousands)

- / Westbound Entrance, Eastbound Exit
- \ Eastbound Entrance, Westbound Exit
- Frontage Road Connection
- Intersection Street / Highway Connection



| Managed Lanes | | Legend | | (Volumes in Thousands) |
|--|---|--|--|------------------------|
| Three Managed Lanes | Does Not Exist in Modified Access | Westbound Entrance, Eastbound Exit | | |
| Two Managed Lanes | General Purpose Lanes | Eastbound Entrance, Westbound Exit | | |
| Reversible Lanes | Open A.M. Period (6:00am – 9:00am) Only | Frontage Road Connection | | |
| Open Westbound A.M. Period (6:00-9:00am) | Open P.M. Period (3:00pm - 7:00pm) Only | Intersection Street / Highway Connection | | |
| Open Eastbound P.M. Period (3:00-7:00pm) | | | | |

TRIP VOLUME BY LINK AND TIME PERIOD - CENTRAL SECTION
Scenario 2 – Year 2015, Base HOV 3+ Free 4 Lanes



| Managed Lanes | | Legend | | (Volumes in Thousands) |
|---------------------------------------|--|---------------------------------------|---|--|
| — | Three Managed Lanes | — | Does Not Exist in Modified Access | / Westbound Entrance, Eastbound Exit |
| — | Two Managed Lanes | — | General Purpose Lanes | \ Eastbound Entrance, Westbound Exit |
| — | Reversible Lanes | — | Open A.M. Period (6:00am – 9:00am) Only | Frontage Road Connection |
| | Open Westbound A.M. Period (6:00-9:00am) | — | Open P.M. Period (3:00pm - 7:00pm) Only | / Intersection Street / Highway Connection |
| | Open Eastbound P.M. Period (3:00-7:00pm) | | | |

TRIP VOLUME BY LINK AND TIME PERIOD - EASTERN SECTION
Scenario 2 – Year 2015, Base HOV 3+ Free 4 Lanes

APPENDIX FIGURE B-6

APPENDIX C

Appendix C

Acronyms and Definitions

ABD--Auto Based Development (ABD), Known colloquially as the suburbs, wherein access is principally provided by the SOV.

AVC--Automatic Vehicle Classification (AVC): Equipment used to classify vehicles by type for purposes of tolling rate assessment.

BRT--Bus Rapid Transit (BRT): Buses running limited-stop service on high-speed routes. Most often this is on dedicated lanes or on limited access highways or both.

CO--Carbon Monoxide (CO): A criteria pollutant as established by the US EPA under NEPA thereby having NAAQS as set by the US EPA.

DART--Dallas Area Rapid Transit (DART); the regional transit agency in Dallas that operates rail and bus transit services in the region.

DNT--Dallas North Tollway (DNT): Self-defining.

FRESIM: A traffic model of the LBJ Freeway GP lanes was developed using the FRESIM micro-simulation program to identify changes in the travel time and delay on different segments of the LBJ GP lanes at differing levels of traffic loadings.

GP--General Purpose (GP) lanes: Free lanes, generally open to all vehicles, on a limited access highway

GD Model-Global Demand (GD Model): The global demand represents the amount of traffic that would be using the LBJ Freeway, including both the MLs and the GP lanes under the various study scenarios.

HDT--Heavy Duty Trucks (HDTs): Trucks with 3 or more axles.

HOV lane: Lanes designed to accommodate non-toll paying High Occupancy Vehicles, e.g., carpools, vanpools and bus transit, most often incorporated into a limited access freeway or toll road or ML facility

HOT--High Occupancy Vehicle/Toll Lane (HOT Lanes): Lanes designed to accommodate non-toll paying High Occupancy Vehicles, e.g., carpools, vanpools and bus transit, along with other toll paying vehicles, e.g., Single Occupant Vehicles (SOVs), Light Duty Trucks (LDTs) and possibly Heavy Duty Trucks (HDTs)

HC--Hydrocarbons (HC): A criteria pollutant as established by the US EPA under NEPA thereby having NAAQS as set by the US EPA

ETC--Electronic Toll Collection (ETC): Use of ITS technology to collect tolls

FBM--Frequent Burger Miles (FBMs): Example of the cross-market product/service subsidization possible with smart card/electronic toll collection technologies.

ITS--Intelligent Transport Systems (ITS): Electronic, telecommunications, video and radio technologies that are used to inform transportation facility users and otherwise assist in operations and management of transportation facilities.

LBJ: Otherwise known as the LBJ Freeway (I.H. 635) or the LBJ Facility in total—as it is today and as it will be in the future--, including the present-day Freeway and the Managed Lanes

LBJML facility: The LBJMLs.

LBJ Freeway (I.H. 635): the LBJ Facility in total—as it is today and as it will be in the future--, including the present-day Freeway and the Managed Lanes.

LBJML--LBJ Managed Lanes (LBJML): The managed lanes proposed to be built on the LBJ Freeway. These are considered, in this study, to be tolled for most vehicles that would use them.

LBJML Project: The planning process surrounding the assessment, planing and design of the LBJMLs.

LBJML Project Team: The representatives from public and private organizations that are participating in the oversight, coordination and management of the planing process surrounding the assessment and design of the LBJML.

LDT--Light Duty Trucks (LDTs): Pick up trucks.

LRT--Light Rail Transit (LRT): Rail transit service most often operated within a single region at moderate speeds with vehicles that can be and often are operated on streets as well as in dedicated corridors.

ML--Managed Lanes (ML): A managed lane facility is one that increases freeway efficiency by packaging various operational and design actions. Lane management operations may be adjusted at any time to better match regional goals.

Market Share Micro-Model: The market share micro-model estimates the share of the total corridor global demand that would use the LBJML vs. the GP lanes. The traffic that is estimated to use the LBJML is based on several factors, including: location of access points to the LBJML, time savings afforded over travel in the GP lanes, and toll rates to be charged.

NAAQS--National Ambient Air Quality Standards (NAAQS): Standards established by the USEPA under the NEPA to protect public health.

NEPA--National Environmental Protection Act (NEPA): The federal act.

NOX--Nitrogen Oxides (NOX): A criteria pollutant as established by the US EPA under NEPA thereby having NAAQS as set by the US EPA.

NCTCOG--North Central Texas Council of Governments (NCTCOG): the designated Metropolitan Planning Organization in the Dallas region.

NTTA--North Texas Toll Authority (NTTA): Self-defining.

SOV--Single Occupant Vehicles (SOVs): Most often used for autos with one person occupying them and sometimes includes LDTs with one person in them.

TxDOT--Texas Department of Transportation (TxDOT): Self-defining.

TOD--Transit Oriented Development (TOD): A form of real estate development, i.e., commercial offices, residential or retail that is based on access being principally provided by transit as opposed to Auto Based Development (ABD), also known colloquially as the suburbs, wherein access is principally provided by the SOV. TOD can be located in urban areas or suburbs.

Tri Rail: Inter-city, heavy-duty commuter rail service in the Dallas Fort Worth region.

U.S. EPA: United States Environmental Protection Agency.

VOT--Value of time (VOT): Monetary measure of market demand for time savings, measured in \$/min.

VMT--Vehicle Miles Traveled (VMT): Cumulative miles of travel for all vehicles on a given facility over a time period.

Violation Enforcement Camera and Lighting Equipment (VES): Violation enforcement systems.

Wilbur Smith Associates (WSA): The consultant firm that completed this study under contract to HNTB/TxDOT.